Organisation des Nations Unies pour l'éducation, la science et la culture

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PERÚ Ministerio de Cultura

CHANKILLO SOLAR OBSERVATORY AND CEREMONIAL CENTER

Nomination of property for inscription on
The World Heritage List

Republic of Peru - January 2019

2. DESCRIPTION

2.a Description of property

The Chankillo Solar Observatory and ceremonial center is a prehistoric site with astronomical, ritual, defensive and administrative functions, occupied between 250 and 200 BC. It is located on the north-central coast of Peru, Ancash department, 15 km east of the Pacific Ocean and 12 km south of the city of Casma. It faces the steep western slopes of Cordillera de los Andes, between 80 and 1180 masl, in a desert that has remained practically without major geological changes since the Pleistocene. The area occupied by Chankillo is adjacent to the irrigated valleys of the southern branch, called Casma or Grande river, of the Casma and Sechin river basin, and made up of mountains, rocky outcrops, dry ravines, sand ramps and dunes, and carob tree forests, that largely retain their original conditions. However, there have been considerable fluctuations in the course and the size of the river, which have shaped the area into two different parts: on the one hand, a mountainous area formed by Cerro Mucho Malo, and on the other wide sand ramps and low hill chains occupied by the Chankillo monumental archaeological zone (Map 1). As seen from the latter, Mucho Malo forms a near, elevated horizon, while in the bearing of the Chankillo site the horizon is distant and relatively low, unique in the entire Casma region. Additionally, the local terrain, which includes a mountain range adjacent to the Pacific Ocean, usually prevents the winter fog, very common in coastal Peru, from entering this part of the valley, creating often favorable weather conditions for the observation of celestial objects. Thus, Chankillo is found in an area with naturally exceptional conditions for astronomical uses (Ghezzi and Guadalupe 2013).

The Casma valley, like the others on the Peruvian coast, has been for long an oasis that made the settlement of human populations, which in this valley goes back several millennia, possible in an inhospitable territory. Despite the favorable conditions that such oases offer for its occupation, Chankillo was in use for a relatively brief time between 250 and 200 BC (Ghezzi 2016), during a late phase of the Early Horizon Period (500-200 BC) of Peruvian prehistory (Table 2-1).

Chankillo is a planned site. Each of its cultural elements relates to all others, as well as to elements of its natural environment and the contemporary prehistoric settlements along the valley. This creates a sense of unity and synchrony. For this reason, the definition of the extension of the property and its buffer zone considers several factors:

a) The physical area occupied by buildings that incorporate astronomical functions—the Temple of the Pillars, Observatory Building, Thirteen Towers, and East Observing Point—all within a "monumental archaeological zone" defined by the Peruvian state. The first boundary polygon of this zone was defined in 2008 (INC 2008). Later, based on the

extension of prehistoric occupations reported by archaeological surveys (Ghezzi 2003, Ghezzi, Salcedo et al. 2013), it was reviewed and updated to include surrounding areas up to 2112 ha, encompassing quarries, workshops, geoglyphs and many other prehistoric features (Benavides and Vásquez 2015). (Map 4)

Absolute chronology (CalBC)	Central Andean chronology	Moche (Billman 1997)	Chavin (Burger 2016)	Santa (Wilson 1988)	Nepeña (Shibata 2014)	Casma (Wilson 1995)	Culebras (Giersz 2007)
0	Early Intermediate	Late Salinar	Huaras				
100							Ampanu
200				Vinzos		Patazca	
300	late Early Horizon	Early Salinar					
350					Samanco		
400							
500	middle Early Horizon		Janabarriu				
600		Late Guañape		Cayhuamarca	Nepena	Pallka	Panteon
700							
800	early EH		Chakinani				
900					Cerro Blanco		
1000			Urabarriu				
1100		Middle Guanape					
1200					Huambocayan		
1300	Initial Period						
1400						Moxeke	Culebras
1500							
1600		Early Guañape					
1700							
1800							

Table 2-1. General chronological chart of the Central Andean area and relevant local chronologies. The gray bar represents the brief time of occupation of Chankillo (Wilson 1988, Wilson 1995, Billman 1997, Giersz 2007, Shibata 2014, Burger 2016)

b) Elements of the natural environment outside the monumental archaeological zone used as astronomical markers, such as the southeastern slope of Cerro Mucho Malo, and others in the zone of visual influence between 5 and 15 km away from the Temple of the Pillars, which are within the visual horizon of the observing points. Cerro Mucho Malo is also included as part of the property, because it was used as a natural astronomical marker (Map 2).

c) Elements of the natural environment outside the monumental archaeological zone that still preserve a great part of the original visual landscape, such as Cerro Mongon and the Manchan dune to the west, Cerro La Cumbre and Cerros Los Medanos to the south, and the chain of high hills and visible peaks found to the north and south of Cerro Mucho Malo, integrated into the landscape of dunes that characterizes Chankillo and the Casma coastline in general (Map 1).

d) Archaeological sites outside the monumental archaeological zone, associated with Chankillo, both because of their contemporaneity, their visual connection (Huaca A and

Pampa de Llamas) and because they are linked by roads (Cantina). To these must be added the presence of a section of Qhapaq Ñan (the Inka road) between the Casma Valley and the coastline, possibly constructed during the time of Chankillo, which would give this road a temporal extension of more than 1600 years (Map 5).

e) The existence in the areas of interaction within the lower Casma valley of monumental archaeological sites (Sechín Bajo, Cerro Sechín, Las Aldas, Sechín Alto, Taukachi-Konkan, Moxeke, Huaca A, Pampa de las Llamas, Cantina, San Diego, Huerequeque, Pallka, etc.), which highlight Chankillo as the culmination of a long and unique process of development and accumulation of astronomical knowledge during the prehistoric era (Map 5).

The interconnection of the various cultural and natural elements underlies the proposed extent of the property and buffer zone of Chankillo. The buffer zone aims to protect the coastal desert around the property in order to guarantee the continuity of its astronomical function and of the landscape values inherent to this function. It includes a zone of visual influence formed by the chain of mountain tops in the sightline of the astronomical horizon, agricultural zones, Andean foothills, the coastal desert, zones of cultural and natural heritage, and zones with terrain or materials necessary for the preservation of the landscape.

The property is composed of two parts, a prehistoric ceremonial center (Chankillo monumental archaeological zone), and a natural sector composed by part of the adjacent Cerro Mucho Malo (Map 2). The two parts, demarcated by polygons, are:

I. The Chankillo monumental archaeological zone (2112 ha), as defined by the Ministry of Culture. It is a ceremonial center dedicated to a solar cult, which contains a solar observatory. Its main buildings are:

   a) The Chankillo Solar Observatory, composed of the Thirteen Towers, a line of buildings on a natural hill that functioned as astronomical markers, and two observing points from which the annual solar cycle is observed using these towers: the Western Observing Point, an open entranceway in a building known as the Observatory Building, and the Eastern Observing Point, contained within an isolated small building in an adjacent plaza.
   b) The Fortified Temple, whose interior houses several buildings, including the Temple of the Pillars, that contain elements with an astronomical function.

c) The Observatory Building, at the foot of the hill where the row of towers was built, which contains not only the Western Observing Point but also an entrance facing the Fortified Temple which itself has possible astronomical significance.
d) The Administrative Center, a large platform with a U-shaped atrium and a series of enclosures and courtyards, from which the public rites and ceremonies of solar worship were managed.

II. Cerro Mucho Malo (2368 ha). This massif forms a high horizon whose southern slope becomes a natural marker when, as seen from the Western Observing Point, it intersects the artificial profile of the Thirteen Towers to form a continuous astronomical horizon. It is part of the coastal foothills of the western chain of the Andes mountain range and sits next to a pronounced bend in the Casma River. Its exposed bedrock belongs to the Early Cretaceous. For a few million years, tectonic elevation, fluvial and pluvial erosion were substantial. There were considerable fluctuations in the course and size of the river. It is composed mainly of andesite, which is a harder rock than the tonalite characterizing the Chankillo zone; therefore, differential erosion explains why this hill is much higher than the surrounding terrain (Ghezzi and Guadalupe 2013).

2.a.1 Chankillo monumental archaeological zone

The area is occupied by Chankillo, a prehistoric ceremonial center dedicated to a solar cult. Its orientation is defined broadly by the alignment between the single restricted entrance on the atrium of the Temple of the Pillars and the single direct entrance to the Administrative Center (Figure 2-1). This defines a site axis with an azimuth of approximately 120° that connects the Temple of the Pillars, the center of the Observatory Building and the Administrative Center, and passes through the gap between Towers 12 and 13, where the southern end of the line of towers bends round until it is perpendicular to the axis. This orientation is maintained throughout the site—even buildings not along the main axis share it—and it is broadly solstitial (Ghezzi and Ruggles 2011). For further details, see Section 2.b.6 The "site axis" and the broadly solstitial site alignment of all the principal buildings at the site.

The main buildings are the Fortified Temple (Figure 2-1A), the Thirteen Towers (Figure 2-1B) and Observatory Building (Figure 2-1C), components of the Chankillo Solar Observatory, and the Administrative Center (Figure 2-1D). A detailed description follows.

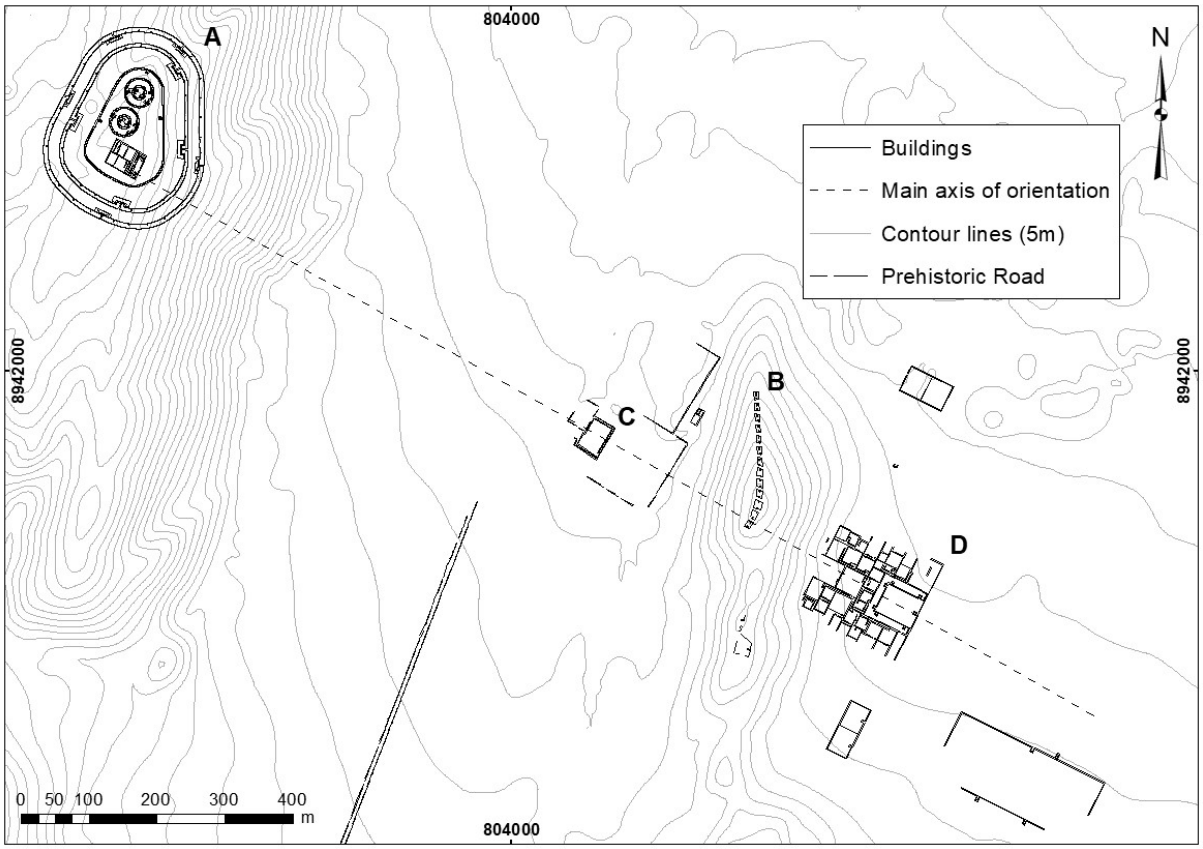


Figure 2-1. Map of the main Chankillo monuments

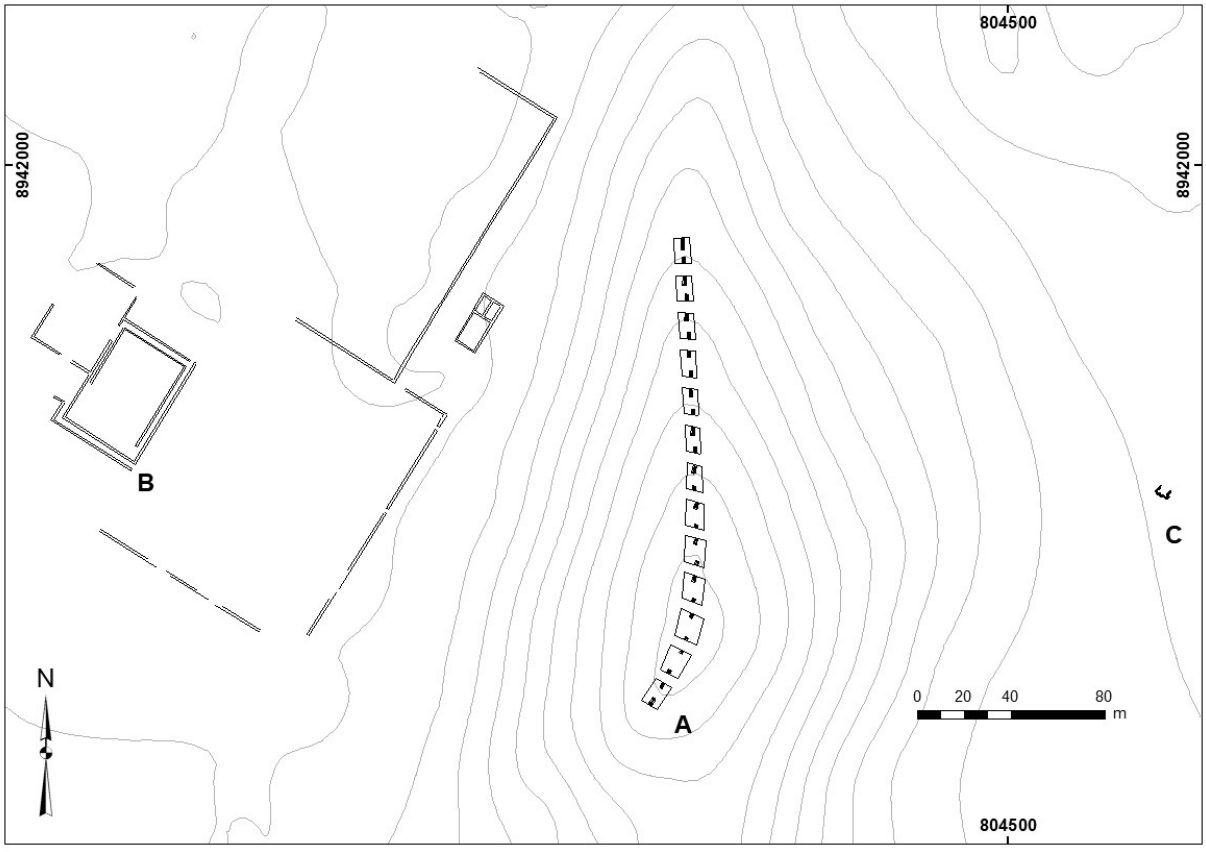


Figure 2-2. The Chankillo Solar Observatory

2.a.1.a The Chankillo Solar Observatory

It is composed of the Thirteen Towers (Figure 2-2A), the Observatory Building, containing the Western Observing Point (Figure 2-2B), and the Eastern Observing Point (Figure 2-2C).

The Thirteen Towers

The towers are a row of thirteen cuboidal constructions built of stone and mortar along a low ridge roughly at the center of Chankillo (Figure 2-3). They are regularly spaced and run broadly N-S, although Towers 11 through 13 turn noticeably southwest to become perpendicular to the site axis (Figure 2-4). Since 2007 it has been recognized that the towers were horizon markers enabling privileged observers to accurately track the seasonal passage of the sun throughout the year. From two observing points to the W and E, the towers span, respectively, the entire range of sunrise and sunset positions as the sun moves between its limits at the solstices, including a part of Cerro Mucho Malo to complete the profile in the former case (Ghezzi and Ruggles 2007).

Figure 2-3. The Thirteen Towers (view to the east)

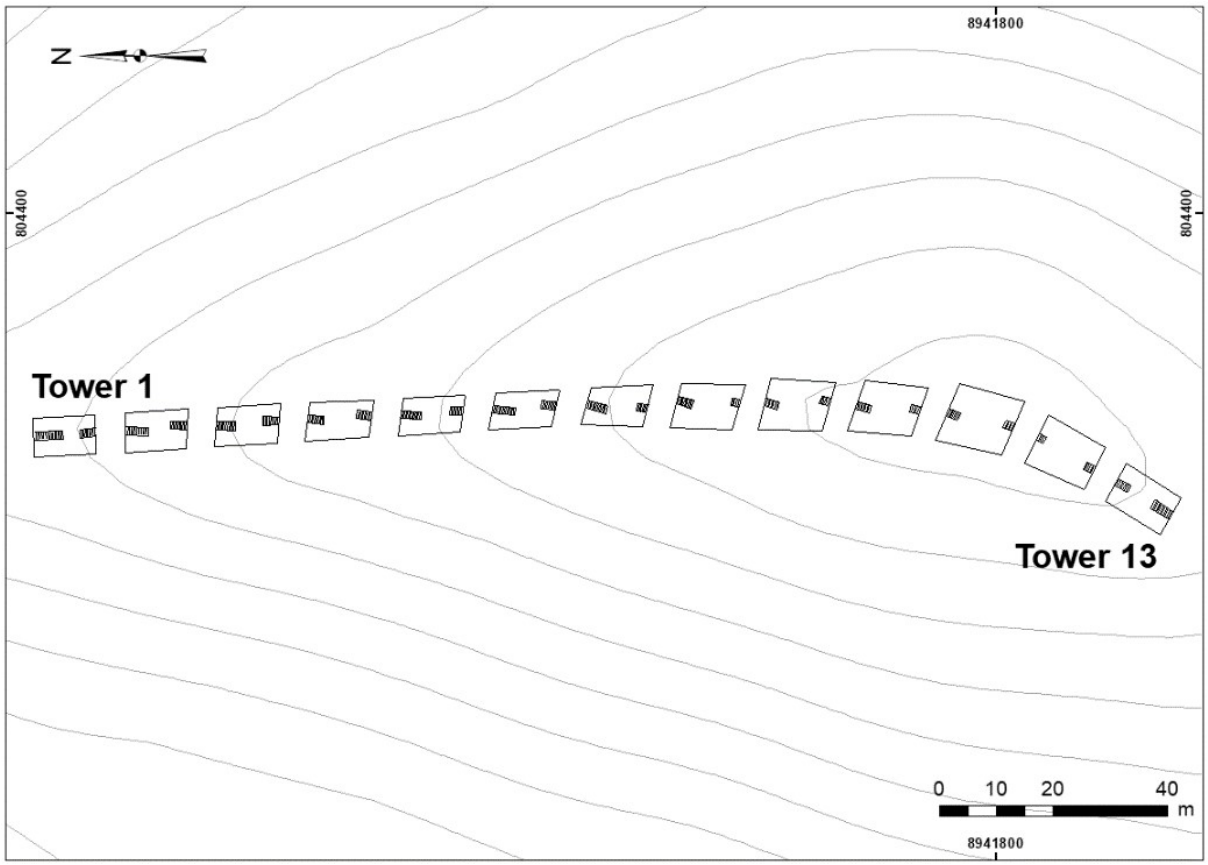


Figure 2-4. Map of the Thirteen Towers

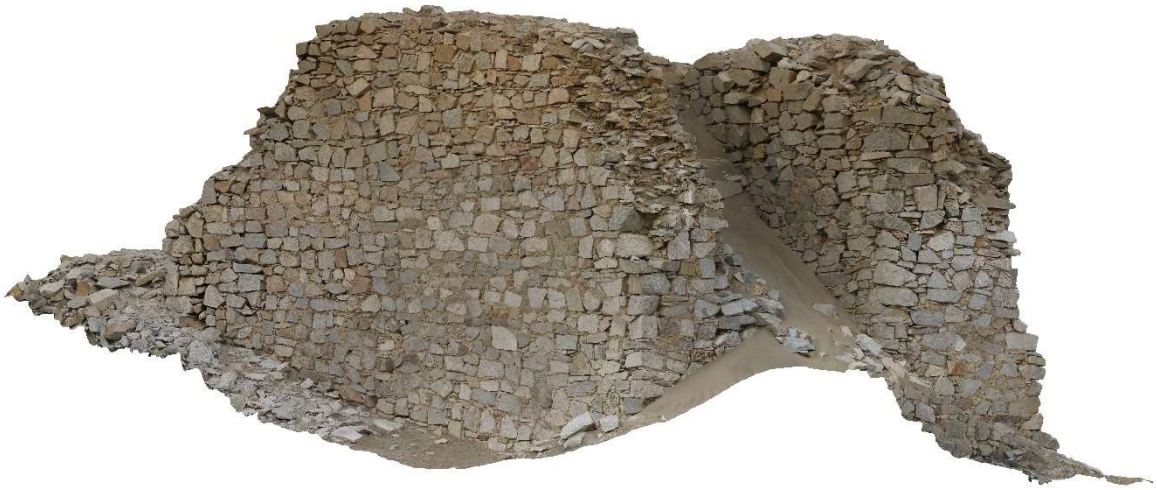


Figure 2-5. 3D Model of Tower 1

The towers are well preserved, except for Towers 4 and 13, whose east walls and fills have largely collapsed. However, enough fabric survives to recognize the main components of their design and construction (Figure 2-5; Figure 2-6). Each tower is composed of four retaining walls, with steep stairways built between parallel walls recessed into the north and south walls, holding a fill of carefully laid stone and mortar. The stone blocks in these walls are mostly tonalite, with some granite. In contrast with the Fortified Temple, the stones tend to be smaller, and basal stones can be the same size or smaller than those in the rest of the wall. Most towers were built directly over leveled bedrock, without a foundation. Tower 13, with a large foundation, is the exception.

The ground plan of the towers varies from rectangular to rhomboidal. For example, the corner angles at Tower 7 range from 73° to 109° approximately. The size (75-125 m^2) and height (2-6 m) of the towers also vary widely, with the northernmost towers being higher than the rest, apparently to compensate for the descent in the height of the hill in this end. However, the towers are regularly spaced: the gaps between them range only between 4.7 and 5.1 m. Additionally, Towers 11 and 12 have a greater than average area; combined with the change in orientation, Tower 13 would remain hidden for some observers to the east.

On each of the shorter walls (north and south), a flight of stairs leads up to the summit. The northern stairways are usually centered along this side, though not always aligned with the long axis of the tower. The southern stairways, on the other hand, are often offset towards the east side. All the stairs are narrow, only 1.4-1.5 m wide. Since the height of the towers varies widely, the same is true of the total rise of the stairways (1.3-5.2 m).

Tower 9 was excavated (Ghezzi, Alvarez et al. 2013). The stairs were built with stone blocks and slabs. Each step is composed of several blocks joined with mortar. Relatively larger blocks are found in the landing. Often the blocks have two faces, so they form the treads, or part of the stair that was stepped on, and the risers, or vertical portions between each tread. Usually a block laid on the edge of a step is interlocked with the sidewalls. The steps in the northern stairway of Tower 9 have treads 24 cm deep, and risers 24 cm high, while those in the southern stairway have 24 cm-deep treads and 18 cm-high risers (Figure 2-7). These dimensions would suggest that the northern stairs favored going up, while the southern stairs favored going down (Hoskins and Milke 2013). However, the stairways, which are less steep than those in the Fortified Temple, were not meant for defense, and such differences in the heights of the risers may be related to the direction of ritual ascent and descent from the towers, as suggested by Malville (2011). Likewise, the importance of the concept of duality has been documented in the Andes, and its manifestation

in these dual stairs, as well as in those in the entrance plaza to the Administrative Center and in the atrium of the Temple of the Pillars, and the use of the double-step motif in the slitted pillars of the temple and in sculptural pottery vessels found at Chankillo, reflect the symbolic importance of the stairs of the Thirteen Towers (Ghezzi 2016). Some tower summit floors have been partially preserved. They consist of a layer of coarse sand, which may have been covered with mud (Figure 2-8). The existence of the stairs strongly suggests that the summits were important loci of ritual activity related to the solar cult, although there is no direct evidence of such practices.

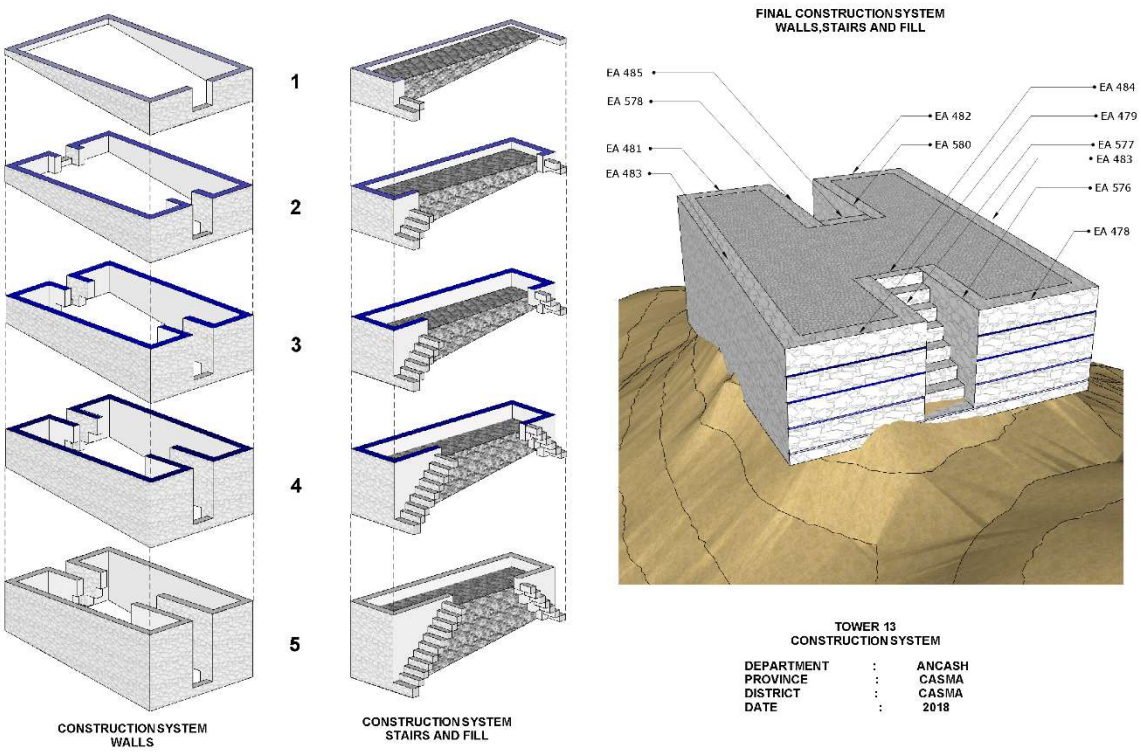


Figure 2-6. Reconstruction of the construction system in Tower 13. Stone masonry walls hold a fill of stone and mortar. Stairways are cut in on the north and south sides. The top is capped with small stone slabs, laid flat

Figure 2-7. Tower 9 after excavation, showing its form and construction technique

Figure 2-8. View of the summit of Tower 6

The Observatory Building and the Western Observing Point

There is a group of buildings immediately west of the towers (Figure 2-9). Structures 2 and 3 are walled courtyards largely destroyed by a prehistoric flood of unknown date, as suggested by a deep gully running through them. Aerial photos and contour maps suggest that Structure 2 was square, 130 m on each side. Only its eastern side remains, a very tall wall that still stands at 7 m high. Windblown and flood deposits cover its base, suggesting that it might have been even taller. Despite its height, it is not interpreted as defensive. A small direct entrance between the surviving walls of both structures (Figure 2-9E), leads to Structure 1, a small building with three rooms and surface evidence of food and drink preparation and/or serving. It is curtained from view by the high wall of Structure 2. Possibly, the intended function of the high wall is to separate visually the service area from the sacred area directly to the west.

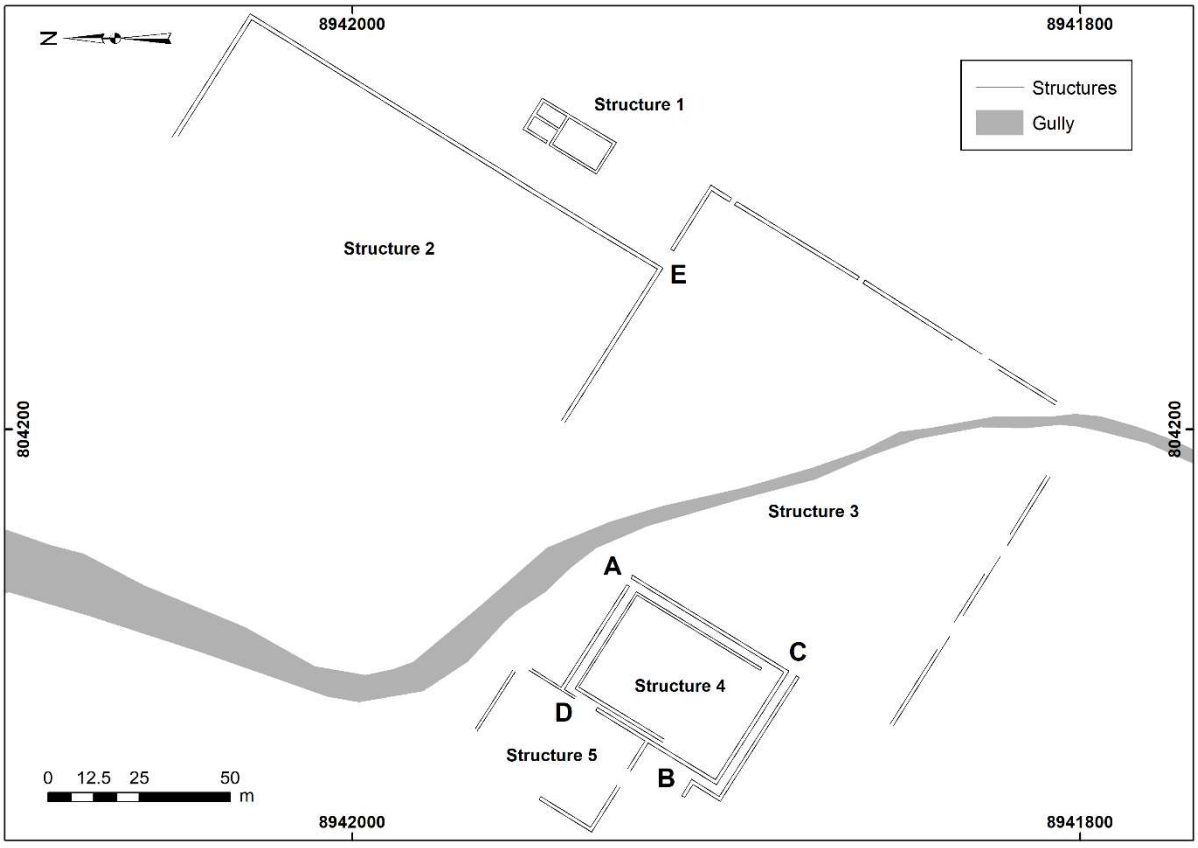


Figure 2-9. The Observatory Building and nearby structures

Structure 4 is rectangular (53.6 x 40.3 m). Its northeast entrance (Figure 2-9A) leads to two internal corridors running along the perimeter walls, which exit to the opposite side (south) of the interior courtyard. Another corridor, this time external, runs along the southwest perimeter wall (Figure 2-9, B-C). It is unique for various reasons. For instance, it has a right-turn baffled entrance (Figure 2-9B). A right-turn baffle is unusual at Chankillo; more common left-turn baffles protect

against attackers carrying shields on their left, exposed by the turn (Keeley, Fontana et al. 2007). A right-turn baffle thus suggests non-military control of the entrance to the corridor. The corridor widens towards its eastern end exit, an open doorway (Figure 2-9C) that is unique at Chankillo for lacking the typical wall niches that hold doors in all other entrances, large and small, known at this site. From this open doorway the view of the towers and their surroundings is unimpeded (Figure 2-10). Additionally, important votive offerings were found in the area around the exit. Thus, the purpose of the corridor was not to channel traffic from its access restricted for social control at one end to the interior of Structure 4, but to the doorway facing directly the Thirteen Towers on the other end. Owing to these attributes and its location, the open doorway was identified as the Western Observing Point (Figure 2-11), from which the Thirteen Towers and Cerro Mucho Malo were used as solar horizon markers (Ghezzi and Ruggles 2007). Structure 4 has come to be known as the "Observatory Building". For further details, see Section 2.b.1.a The viewshed from Western Observing Point (WOP) to the Thirteen Towers together with part of Cerro Mucho Malo.

Figure 2-10. View of the Thirteen Towers from the Western Observing Point

Structure 5 is a rectangular building abutting the northwest corner of Structure 4. The adobe on its surface, a material that was not used until centuries after the abandonment of Chankillo, suggests a later reoccupation of the Observatory, although the purpose is not well understood. Applying principles of symmetry, evident throughout Chankillo, it has been proposed that this construction obscures a possible doorway in the Observatory Building at the corner opposite to the Western Observing Point (Figure 2-9D). From here, the Fortified Temple stands out on the horizon, offering viewpoints in the westerly direction that could reference astronomical phenomena over the Temple skyline. Research suggests that this possible doorway could have been used for observations of the June sun descending over the Temple of the Pillars. In addition, ceremonies relating both to the sun and moon might have taken place at the full moon nearest the December solstice (see Section 2.b.3 The viewshed from the WNW entrance of the Observatory Building to the Fortified Temple). Since the orientation of the corridor points toward the Southern Keep (see Section The Keeps), it would imply that from the time of its construction, this Keep was associated with the moon, just as the Temple of the Pillars was associated with the sun.

Figure 2-11. June solstice sunrise, as seen from Western Observing Point

Figure 2-12. September equinox sunset, as seen from Eastern Observing Point

The Eastern Observing Point

A small building, 200 m east of the Thirteen Towers (Figure 2-2C), contains what has been identified as the Eastern Observing Point (Ghezzi and Ruggles 2007). The building no longer stands; it suffered deterioration owing to its proximity to areas of human and animal transit. However, its foundations partially survive, in their original orientation and position, below the surface. The position of this structure mirrors almost exactly the Western Observing Point; it has the same distance to the towers and a similar elevation, and both are aligned on an east-west axis perpendicular to the Thirteen Towers.

No other built feature was identified by survey or excavation in this area (Ghezzi 2003). Recent sub-surface remote sensing (Huayhua and Sueldo 2018) confirms that this structure is completely isolated in a 200 m by 160 m survey area of open space bounded by the Administrative Center and the hill where the Thirteen Towers are found (Figure 2-14). It is possible that the structure is larger than revealed by excavations. The small uncertainty in the exact location of the Eastern Observing Point is insufficient to affect the conclusion, clearly revealed by the archaeoastronomical data, that this small building, broadly solstitially aligned like the rest of the site, included an entrance or platform that acted as a fixed observing point to view the seasonal passage of the sun over the Thirteen Towers. From here, the line of visible towers coincides with the range of sunset positions throughout the solar year (Figure 2-12, Figure 2-13). Further details in section 2.b.1.b The viewshed from the Eastern Observing Point (EOP) to the Thirteen Towers.

Figure 2-13. View of the Thirteen Towers from the Eastern Observing Point

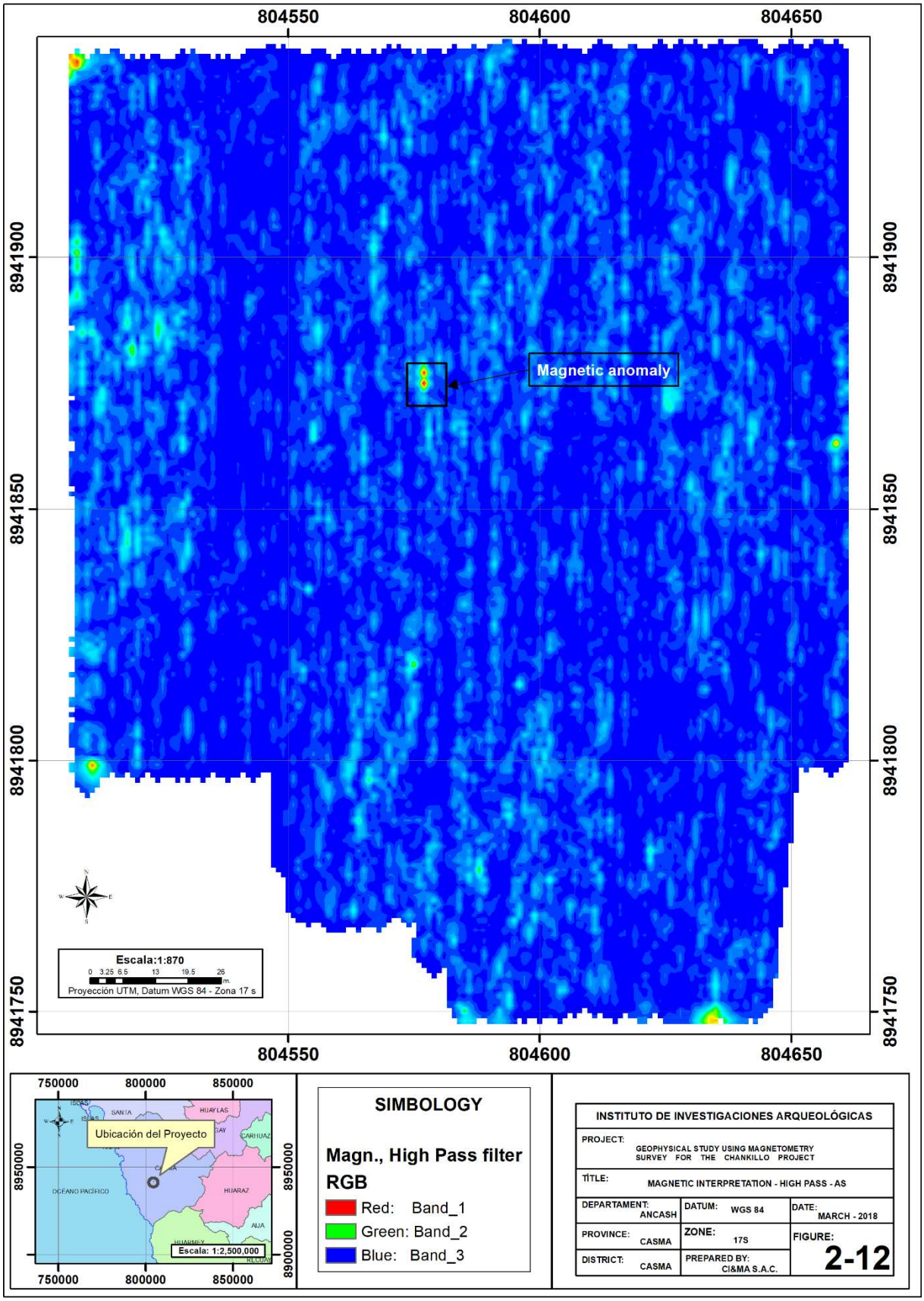


Figure 2-14. Single magnetic anomaly around the center of the survey area coincides with the position of the Eastern Observing Point identified through excavation. Other anomalies toward the edges relate to rising bedrock or standing prehistoric buildings

2.a.1.b The Fortified Temple

The Fortified Temple is a large (area 55,134 m^2, perimeter 851 m) hilltop building composed of three inner structures (a rectangular temple and two keeps with a circular ground plan) surrounded by three concentric ovoid defensive walls through which large baffled gates provide access to the interior (Figure 2-15, Figure 2-16).

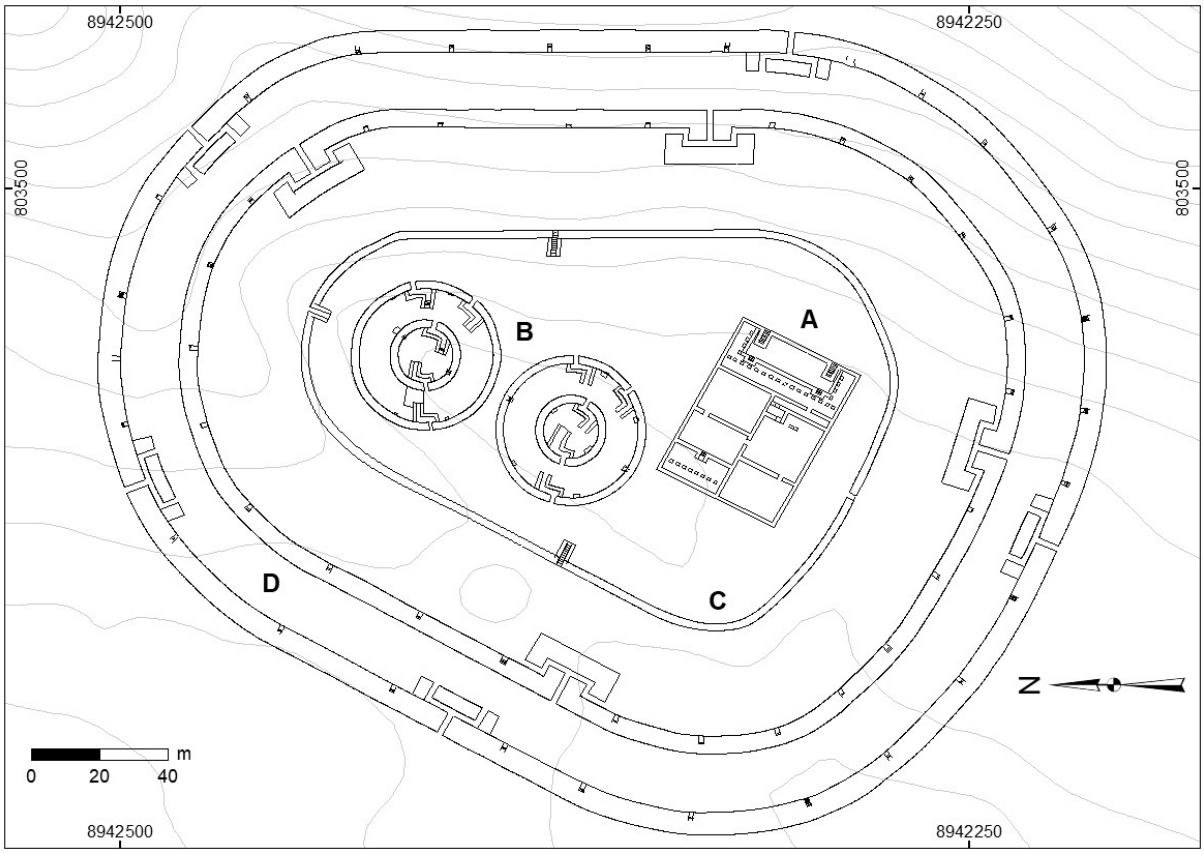


Figure 2-15. Plan of the Fortified Temple

The building´s location is defensible, yet, intriguingly, it does not occupy the highest ground on this hilltop, leaving the fort vulnerable to attack from its west flank. Built on the edge of the hilltop, where the summit is to the west and the ground drops away abruptly to the east, it appears as though, counter-strategically, the fort is yielding higher ground. This apparent design flaw was actually a compromise between interconnectivity and defensive strategy: the eastern defensive walls could rise tall from the slope without blocking the view to the east from the interior structures (Figure 2-16). Thus, the inner buildings were well protected while visibility to and from the ceremonial center to the east and the eastern horizon was kept (Ghezzi 2006). Visibility maps of Chankillo show that visual interconnectivity between different areas of the site was important in choosing the location not just of the Fortified Temple but of buildings and other features throughout the site (see 2.b.5 The sightline from certain limited areas in the plaza to the entrance

to the Temple of the Pillars). Additionally, this compromise between visibility and the location of defenses was achieved without sacrificing the apparent goal of erecting two identical ovoid concentric walls (Figure 2-15D). It would have been very difficult to accomplish, given the uneven terrain, and it could only have been done by ingeniously projecting a pre-conceived architectural design. It shows great precision in the conception and execution of this unusual form.

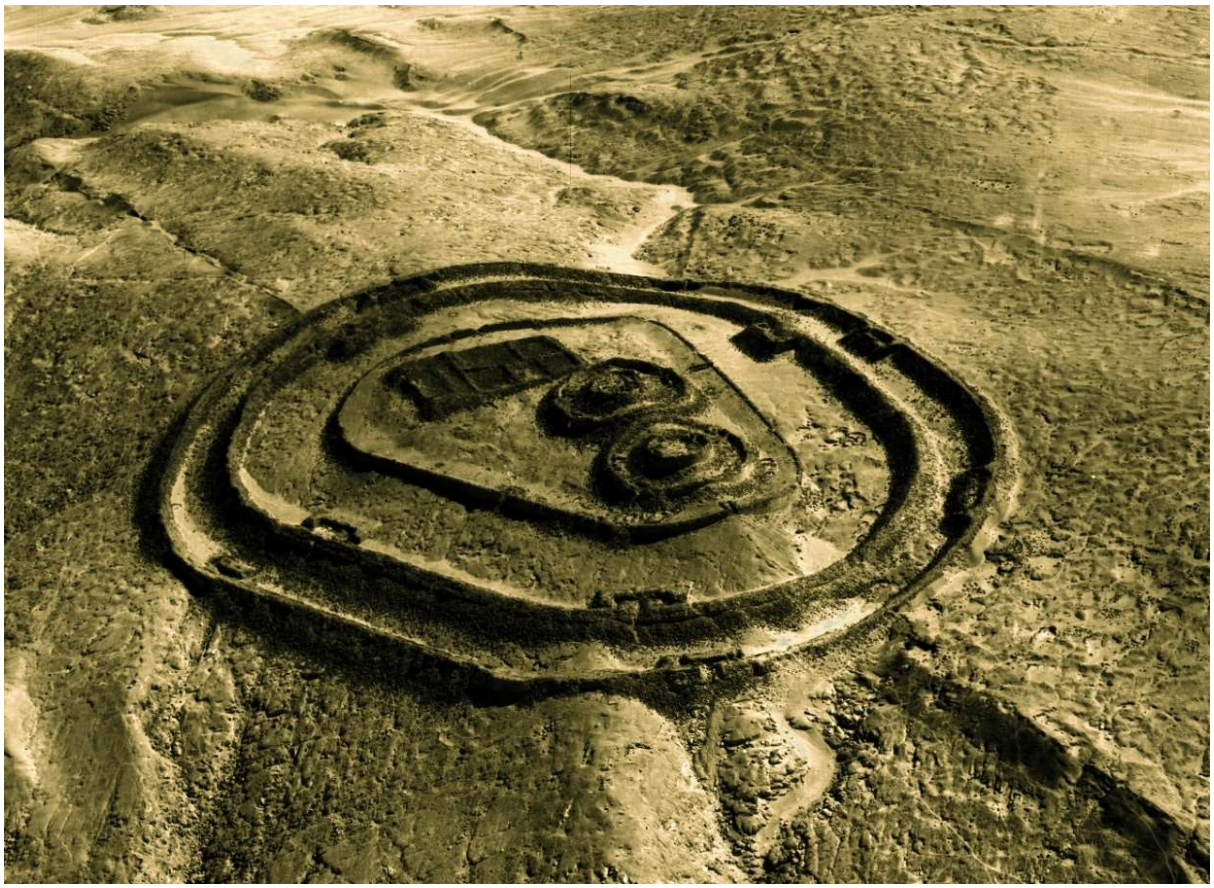


Figure 2-16. Aerial view (from the NNE towards the SSW) of the Fortified Temple (Servicio Aerofotografico Nacional, Peru)

The outer concentric walls, designated Defensive Wall 1 (outer) and Defensive Wall 2 (inner), are massive and tall, ranging from 5.5 to 6.5 m thick, and still standing over 5 m high in some places. They are compound walls, comprising up to 5 parallel sections of wall and fill (Figure 2-17), wide enough to support defenses on the top while maintaining rigidity and stability. The tops of the walls were accessed from inside by stairways meant to be used only from the interior of the building.

Although the Chankillo stonemasons aimed to lay blocks in coursed rows of uniform height, their product was rustic, and no decoration was attempted with the stones. Wall faces, on the other hand, were always finished and often painted white, gray, beige, yellow or red ochre (Ghezzi,

Alvarez et al. 2013). Excavations at the Fortified Temple revealed decoration in vertical panels (Figure 2-18). Three different panels were exposed, one colored beige and another colored white. The third panel had no pigment and was instead textured by a myriad of finger impressions, pressed while the mud in the wall finish was still plastic (Figure 2-19). It is likely that the walls were decorated all around in such variations. From the large plazas below the Fortified Temple, the walls would have resembled a rope or a beaded necklace around the hilltop (Figure 2-20).

Figure 2-17. Preserved portion of a defensive wall, showing its five parallel sections

Figure 2-18. Excavated wall finish showing decorative panels

Figure 2-19. Close up of white (left) and finger-textured panel (right), Fortified Temple

Figure 2-20. View of the Fortified Temple from the main Plaza

While the entrances in the interior concentric wall are small and direct, the outer defensive walls of the Fortified Temple have monumental gates: five in Wall 1, four in Wall 2 (Figure 2-15D). The gates are baffled, a universal feature of fortifications (Keeley, Fontana et al. 2007). The entrance corridor is a wall opening, 7-9 m long, 1.8 m wide, 2.7 m tall, roofed with wooden lintels. The baffled corridor is defined by blocking walls and was not roofed (Figure 2-21).

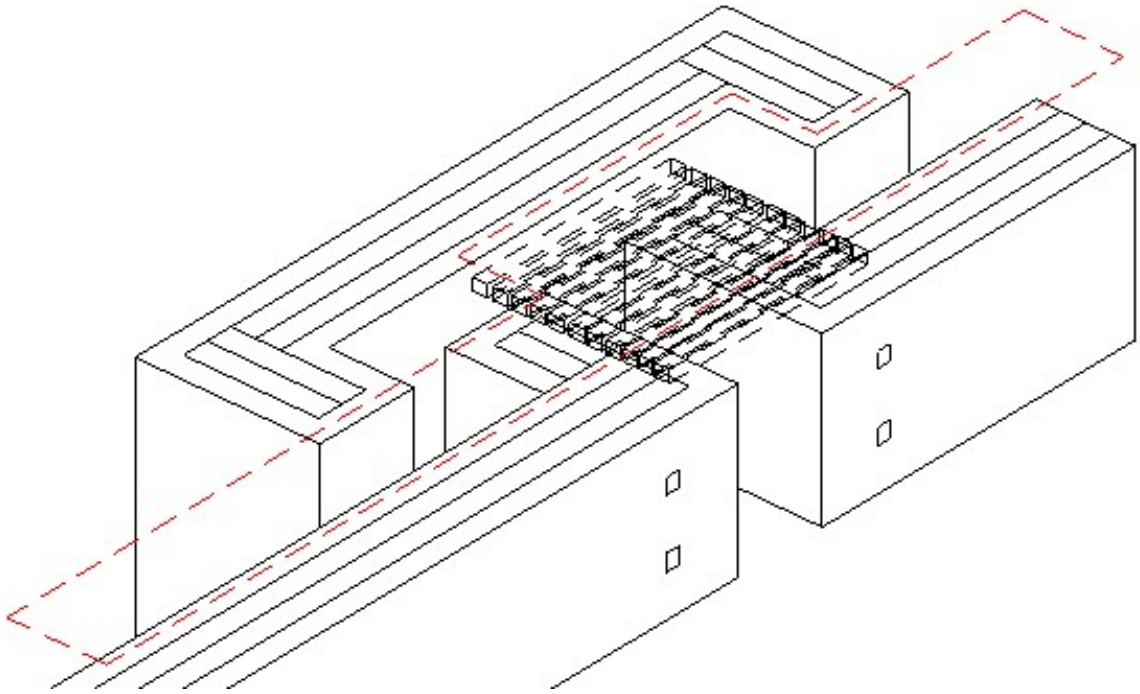


Figure 2-21. Components of a typical Fortified Temple gate, showing defensive wall, rabbets, blocking walls, wall sockets (cajuelas) and lintels

There are wall sockets or *cajuelas* outside each doorway at Chankillo (Figure 2-22). Firmly set inside a socket is a vertical stone pin. The excavations indicate that a door, probably made by tying together wooden poles—as was suggested for Inca architecture (Bingham 1979)—may have hinged vertically on each side of the doorway.

Figure 2-22. Vertical stone pin set at the back of a wall socket

Access through the gates was controlled not only with doors, but also by the maze effect of blocking walls and by second-story defenses. Some gates were false entrances. These defensive measures surround and protect the inner structure known as The Platform, a substantial area (2915 m^2) of artificially raised and leveled open space created using a fill and Wall 3, another 2.5 m-thick defensive wall, as a retaining wall (Figure 2-15C; Figure 2-23). The Platform in turn surrounds the highest point of the hill where the three interior structures of the Fortified Temple—a rectangular temple and two circular keeps—were built (Figure 2-24). The fact that the ground around the three interior structures of the Fortified Temple was filled to form a platform surrounding them contrasts with the fact that the ground between the defensive walls at the Fortified Temple was left largely intact.

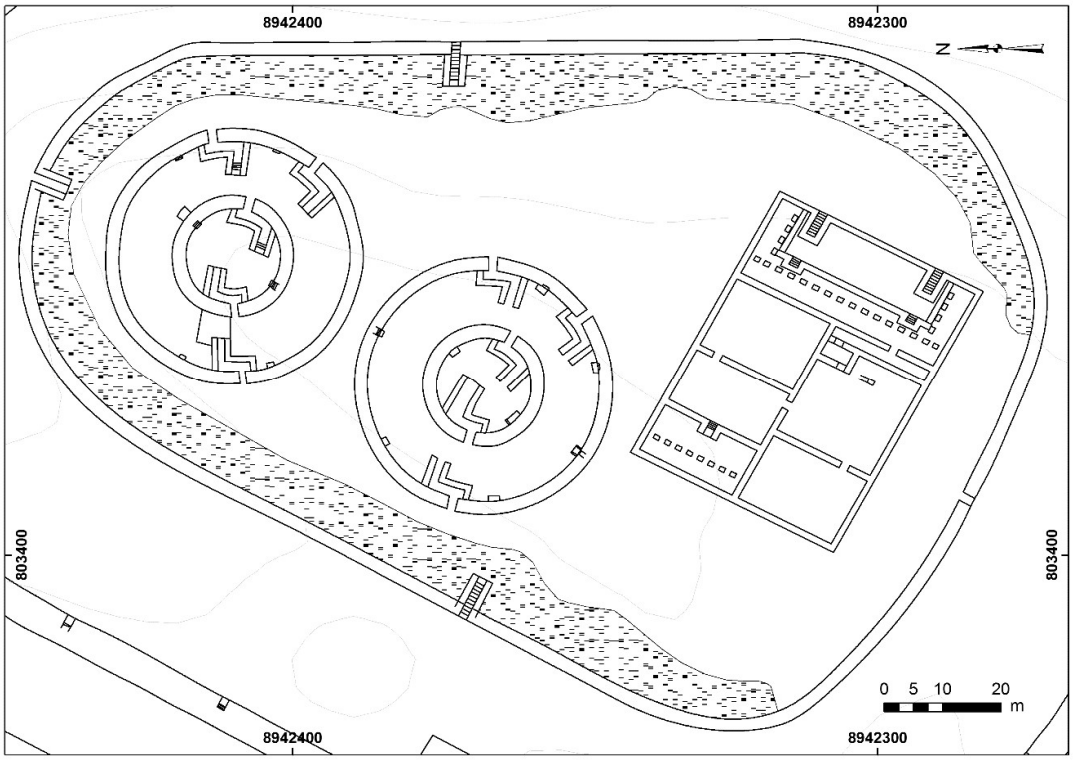


Figure 2-23. Map of The Platform, showing in hatching the filled-in area

Figure 2-24. Oblique 3D view of the Fortified Temple

The Temple of the Pillars

The rectangular building is known as the Temple of the Pillars (Figure 2-15A). It is composed of an atrium with four interconnected rooms at the back (Figure 2-25). Its dimensions are 51.6 m long and 38.7 m wide, and its area is 1,992.7 m^2. Measurements along the perimeter walls yield a WNW–ESE orientation of 119.0°/299.0° and a SSW–NNE orientation of 25.4°/205.4° respectively; thus, they deviate by 3.6° from perpendicularity. The level of precision achieved at Chankillo, and especially the geometrical precision of the Fortified Temple's defensive walls,

implies that this was done for a reason, not just because the Temple of the Pillars was built on uneven terrain. The WNW–ESE orientation is broadly solstitial, like the rest of the site. The SSW–NNE orientation coincides closely with that of the line of centers of the two circular structures inside the Platform and to some extent with that of the WNW segments of the defensive walls. It has no astronomical significance.

The atrium is a rectangular two-level platform connected by pairs of stairways up from the outside and up to the rooms behind. The lower level was accessed from below by staircases on each side, each with 9 steps and a landing. The upper level is U-shaped, with a central dais and two lateral extensions, built atop the lower level; it was accessed by shorter stairways (4 steps and a landing) aligned with those below. The upper level of the platform has pillared galleries (16 pillars on the central dais, 4 on each arm), which originally supported a roof made of perishable materials.

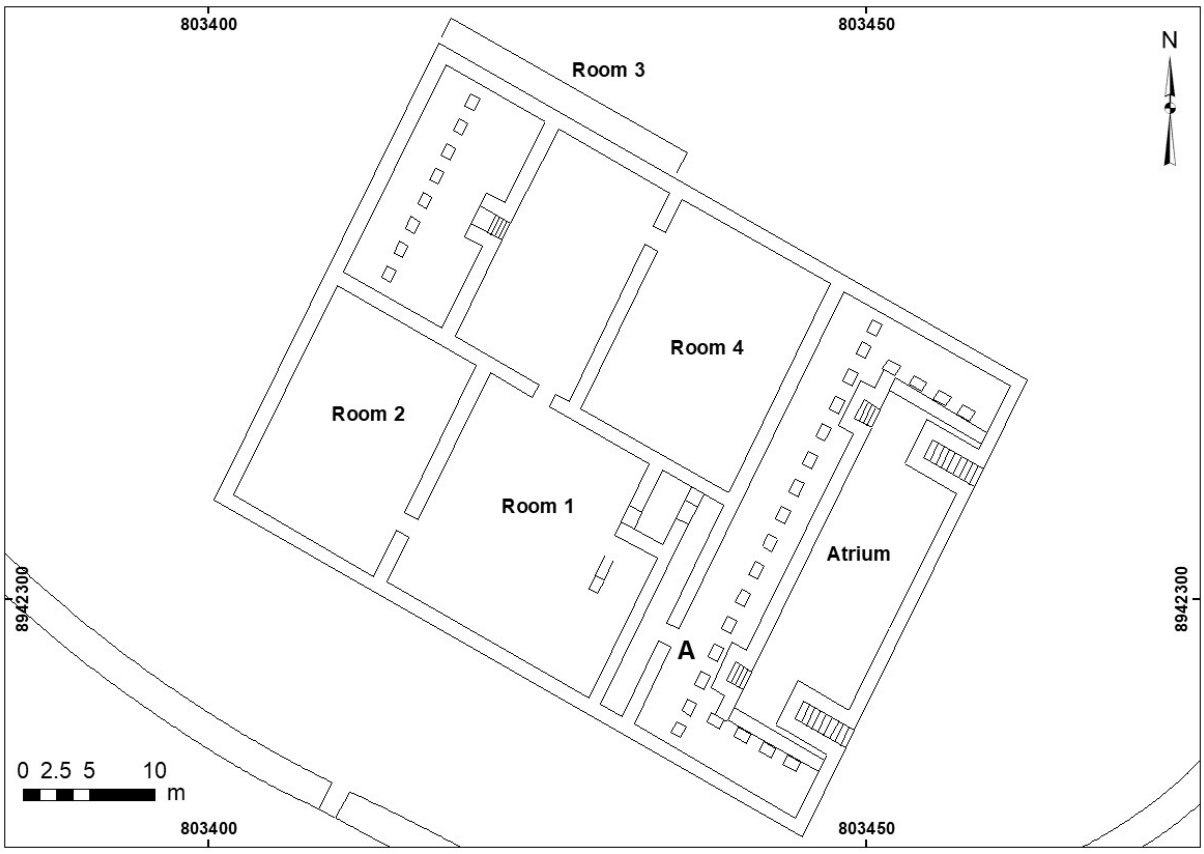


Figure 2-25. The Temple of the Pillars

A narrow doorway, aligned with the SSW flight of stairs, is the only entrance to the secluded rooms in the back of the temple (Figure 2-25A). This circulation pattern, a two-level atrium with stairs on the NNE and SSW sides, where the only entrance to the rest of the building is a restricted access doorway on the SSW side, is repeated at the Administrative Center.

This entrance to the (rooms of the) Temple of the Pillars is one of the most important symbolic positions at Chankillo. The archaeoastronomical evidence supports the idea that elite individuals could have made sudden public appearances here, emerging at auspicious times relating to the solar cycle, and presiding over ceremonies taking place in and around the buildings and plazas below (Ghezzi and Ruggles 2008). The timing would have meant, in effect, that they became part of a sacred manifestation or hierophany (see Section 2.b.5 The sightline from certain limited areas in the plaza to the entrance to the Temple of the Pillars). If that is the case, then from certain areas in the plaza, temple officials standing at the entrance to the Temple of the Pillars could have been seen with the sun setting behind them, thus providing a sort of "hierophany for the masses". The association apparently relates to the Andean concept of the Sun's house or temple, where it dwells during the solstices (Bauer and Dearborn 1995). A similar hierophany would have worked for the moon, which, as seen from the Plaza, sets behind the Temple of the Pillars on certain dates.

The distant eastern horizon is clearly visible from the single entrance and the atrium of the Temple of the Pillars. This spectacular mountainous profile, with a variety of prominent natural features, would have provided natural foresights marking the changing rising position of the sun.

Figure 2-26. Digital visualization of the eastern horizon as viewed from the entrance to the Temple of the Pillars. The lines show the rising paths of the sun at the June solstice (left), equinoxes (center) and December solstice (right) in the 3rd century BC.

A roughly crescentic feature marks broadly the June solstice sunrise, and a minor feature marking more clearly the December solstice sunrise is one of several, so that their cultural significance is questionable. However, the equinoctial sunrise coincides with the most prominent dip in this whole horizon, which is also the lowest point on the horizon within the entire solar rising arc. While there is much specialist discussion about the precise definition and cultural significance of the equinox (Ruggles 2017), it seems likely that this prominent natural feature marking the equinoxes to remarkable precision provided the initial motivation for the establishment, at this spot, of a solar horizon calendar using natural foresights to keep track of the changing position of sunrise with the passage of the seasons. This horizon calendar might well have been the precursor of, and inspiration for, the later construction and use of the Chankillo Solar Observatory for an astronomical purpose (Ghezzi and Ruggles 2011).

The temple entrance leads to four secluded rooms inside the temple that were probably used for ritual functions or elite habitation (Figure 2-25A). It is not a simple, direct entrance; to the contrary, it is cleverly designed: towards the left, a blind corridor disguises the true access, while to the right the corridor leads to the interior through an entrance baffled by two small blocking walls and offset doorways.

The four rectangular rooms are interconnected by direct entrances. The excavations suggest that each entrance had wooden lintels and doors. Room 3 stands out because it has the largest (area 347 m^2) and is the only one that includes a platform. The patio in front of the platform is rectangular and though it is half the total area (173.43 m^2), it is relatively small compared to other patios at Chankillo. Two direct entrances connect this patio to other rooms, while small stairways lead to the platform.

Mural decoration

A notable feature of this patio is its mural decoration. The excavations uncovered painting on the east wall (Figure 2-27). It was preserved near a corner and likely extended further along the wall, although only 4.2 m of finish were preserved. Only the lower 1.7 m of the wall remains, and to judge from the amount of collapse, it is unlikely to have been much higher. In addition, stones excavated from the collapse of the west wall still have finish with incised designs, suggesting that it also contained mural decoration.

Though relatively well preserved overall, the mural has flaked-off in places, leaving gaps that reveal its manufacturing process. The technique is bas-relief, creating an image with shallow

overall depth that is simpler than other relief techniques: less background is carved out. Once the tan wall finish was in place, a thin band of grayish white clay was laid as a base surface on which the design would be carved. It was approximately 55 cm above the floor level, 0.9 m high, and at least 4.2 m long. Next, a grid of deep incisions into the clay and the finish beneath was created using a sharp pointed tool (Figure 2-28). The edge damage of the lines suggests they were traced when the clay was leather-hard. The area covered by the grid is 1.2 m in height and extends along the entire preserved finish, strongly suggesting that the mural continued further north along the wall but was destroyed. There is a degree of irregularity in the grid: most cells average 7-8 cm on a side, but some are as small as 4.6 cm. With the grid as reference, an outline of the design was then traced over with new incisions. Their edge damage suggests that, like the deep incisions, they were traced while the clay was still leather-hard. These incisions employed rectilinear as well as curvilinear motions and are different from the grid. Next, the white clay in the blank spaces within/around the design elements was carved out or excised, leaving behind the design in grayish white against the tan color of the wall finish. Finally, the background spaces around the design were painted white, as suggested by a small area in which this pigment has been preserved. In the bas-relief technique, paint is usually applied to enhance the design. The color combination in the mural does not offer much contrast, though the faded grayish white color of the clay band may have been darker in the past.

Figure 2-27. Mural decoration (EA 43) on east wall of the patio (EA 3)

Figure 2-28. Close-up of the incised grid and design

The design is geometric, with curvilinear elements. It represents two front-facing, interlocked anthropomorphic heads, one upside-down (Figure 2-29). They dominate the design, after the extreme simplification the body; it gives the impression of a synthetic representation of icons known from other media, such as textiles. Atop each head is a horizontal band with ends that curl up on themselves, interpreted as a headdress. The nose is a vertical band ending in a triangular element. The eyes are rectangular with rounded corners, but the iris is almond-shaped. The right-hand head has a circular ear ornament. The most prominent feature of the face is the saw-tooth mouth, represented by a hexagonal shape showing the upper and lower incisors but no fangs. From under the headdress and from the sides of the mouth some curvilinear elements project downwards and turn up to join in a curl or volute. These may represent hair, whiskers, or both.

Three bands extend down from the chin. The central one represents the neck; the other two spread out to represent the arms, which bend in several places to show their articulation. The arms end in a smaller element that curls onto itself. On the side, there are two symmetric elements with similar bends and with appendages: these overlap the arms slightly and could be interpreted as objects held by the arms. A preferable option is that these are "legs," also spread out in perspective for a symmetrical display. The ends of these legs have appendages, one of them opposing the other two, which could be interpreted as the toes in the foot of an animal or bird. Downward along

the leg there is a curved and pointed element, on the same side as the opposing "finger." It may represent a spur, as some birds have.

Comparative imagery is found in the bas-relief facades from Animas Altas, in the lower Ica Valley (Massey 1986, Massey 1991). This site has recently been dated to 400-200 BC (Bacha and Llanos 2010), which is roughly contemporary with Chankillo. Among the similarities with Chankillo are the geometricized head, the alternating or "interlocked" arrangement, the appendages between the heads, the whiskers extending from the mouth on both sides of the face, and the saw-tooth mouth (Helaine Silverman, personal communication). Yet the eyes and noses are very different, and the Chankillo figures lack fangs and bodies entirely. The representation of interlocked extremities between the heads is different from Animas Altas, where the figures are adjacent to each other, but do not interlock.

The eyes are similar to anthropomorphic figures from Paracas Necropolis textiles in linear style (multiple line outlines creating the image) (Bacha and Llanos 2010). The whiskers projecting from the mouth, which recurve into the headdress, are reminiscent of Paracas Necropolis appendages, such as in Figure 116 of the Krannert Art Museum catalogue (Sawyer 1975).

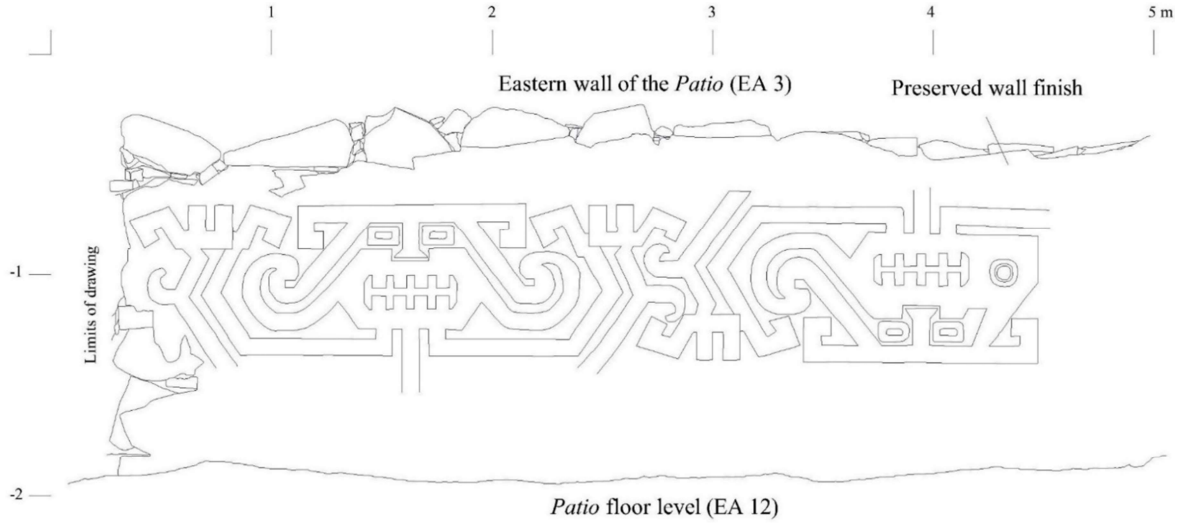


Figure 2-29. Elevation drawing of the mural

Pillared galleries

The platform in Room 3 is 153.05 m^2 in area and elevated 1.5 m above the patio floor. It is formed by a retaining wall holding a fill, with a small stairway (4 steps, 1 landing) at its center. Atop the platform, 8 pillars define the gallery space near the back wall. The pillars were decorated and contained slits forming a double-step motif.

Excavations throughout the temple reveal that its platforms and some of its rooms were partially covered by semi-open, shaded areas known as pillared galleries (Figure 2-30). Similar features have been found in the lower Casma and Nepeña valleys at Huambacho, Sute Bajo, Caylan, Samanco and San Diego (Ghezzi 1997, Cotrina, Peña et al. 2003, Chicoine 2006, Chicoine and Ikehara 2008, Helmer 2014) and hypothetical reconstructions of the structures have been published (Ikehara and Chicoine 2011).

The pillars are rectangular, 1 m long and 0.8 m wide on average. They were built of small tonalite and micaceous andesite blocks, laid with mortar, and finished with mud. They rest on a special foundation that prevented them from sinking into the platform fill, despite the weight of the superstructure supported. Their original height is unknown, owing to their systematic destruction, but a reasonable estimate is 2 m. Chicoine (2006) found those at Huambacho to be to 5 m tall, 3 m of which were under the floor. At San Diego, excavations uncovered a platform with pillars that were sunk 1.8 m into the fill. It was interpreted that a pillared gallery on a patio, 1.8 m high, had been later transformed into a pillared gallery atop a platform (Ghezzi 2004).

The pillars at Chankillo are found in rows of 4 to 16—depending on the length of space to be covered—parallel to and at 2.9-3.5 m from the back wall of the platform or room. They supported a partial roof made from perishable local materials, such as cane, covered in mud. The roof was laid between the row of pillars and the nearby wall to form a covered gallery space. The exact dimensions of any gallery are unknown, but the distances between the pillars and nearby walls are an indication of the area covered. In the atrium of the Temple of the Pillars, the central dais of the upper U-shaped platform has the pillars located 3.5 m from the back wall and 2.15 m from the front wall. In the side arms, they are located on the edge of the platform, 3.5 m from the back wall, and only 50 cm from the front wall. A row of small wooden posts excavated next to this wall suggests that the roof extended past the platform, covering adjacent staircases. In the platform of Room 3, the pillars are located 3.3 m from the back wall and 5.7 m from the front wall. Here, large impressions on the excavated floor indicate that some posts probably lent additional support to the roof, indicating that it may have extended almost 10 m from the back

wall, to cover the entire platform. Finally, in Room 1, a row of pillars was excavated 2.9 m from the back wall. These measurements indicate that, although the intention was to cover as much of the room or platform as possible, the distance between the pillars and the back wall of the gallery was limited to 3.5 m, probably because this was the maximum distance a simple cane superstructure could cover without additional support.

Very little of the pillared galleries has survived. The excavations carried out in the Temple of the Pillars revealed that the walls, pillars, and religious images were intentionally destroyed and buried under a layer of rubble. This event was probably due to a violent conflict with some external power, which ended with the defeat of Chankillo and the abrupt abandonment of the site (Ghezzi 2006).

One pillar was relatively well preserved, though, protected by the very fill that was meant to bury the building (Figure 2-31). Its excavation showed that its function was not just structural: it was adorned with a double three-step motif, similar to known pottery designs at Chankillo, deeply recessed (7 cm) into its front (ESE) and back (WNW) bases. The steps face each other, and on the outer edge of each motif the recess continues to become a narrow, extended gap or **slit** that runs straight through the pillar. There is an additional slit between the two motifs. The three slits are 20 cm high, 8 cm wide, and 77 cm deep, and they have an approximate WNW–ESE orientation of 120.0°/300.0°. Indicators for the presence of the same slit feature were found in the remains of pillars in the Atrium, though no example was as well preserved as the one in Room 3. It is likely that several other pillars at the temple, although not preserved, had such slits. Identical slits were found at Huambacho and Caylan (Chicoine 2006, Chicoine and Ikehara 2008), and at least a few have a similar orientation (Chicoine, personal communication 2015).

The rubble from the destruction of the pillars was dumped at the platform, and its excavation recuperated fragments with hollow spaces, round and straight edges, white or yellow paint, etc. This indicates that the lost portions of the pillars were also modeled and painted to represent sculptural figures. Additionally, stones excavated from the collapsed wall in Room 3 at the back of the pillared gallery contain remains of mud finish with geometric incisions, suggesting that this receiving surface had mural decoration similar to other walls described above.

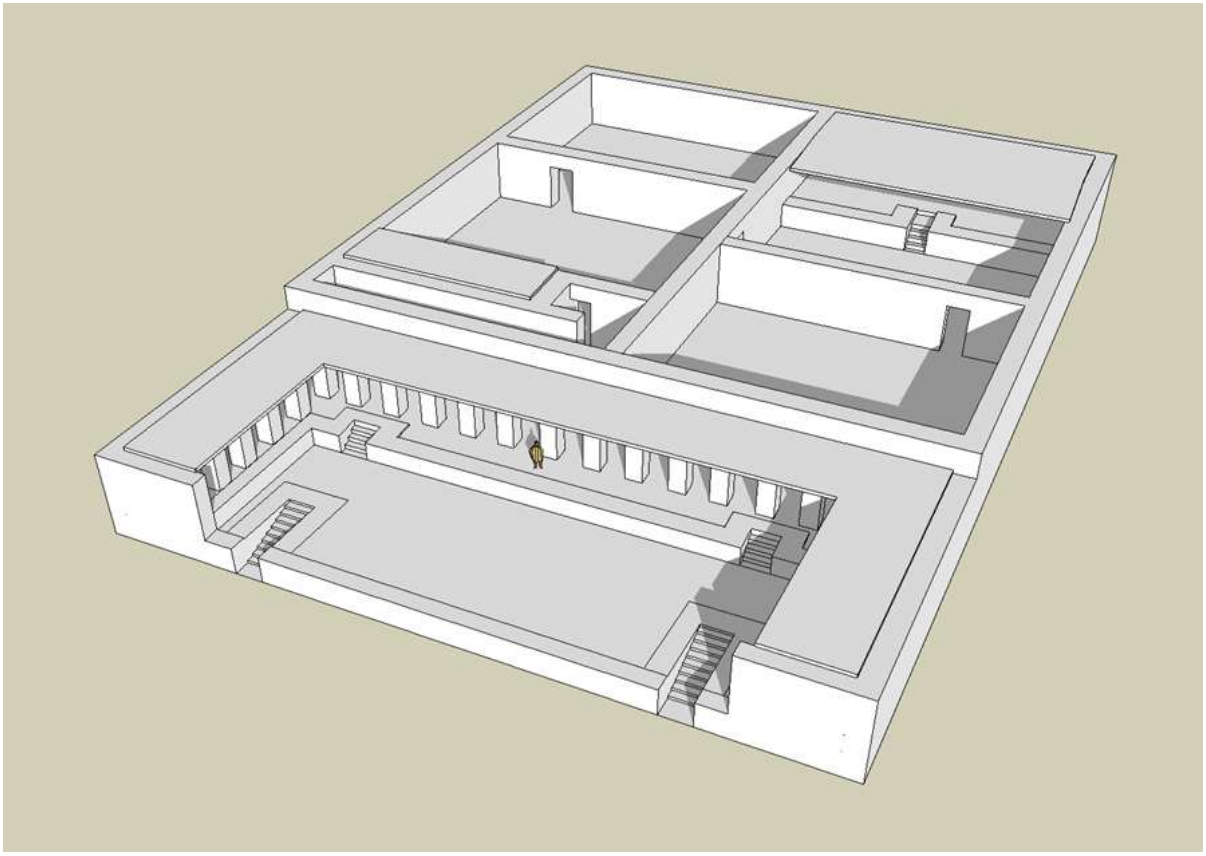


Figure 2-30. The Temple of the Pillars (Ikehara and Chicoine 2011)

Figure 2-31. Pillar (EA 17) from Room 3. The foundation can be seen under the pillar

The pillared galleries at the back of the atrium faced the eastern horizon, unblocked by intervening walls: the low retaining wall at the front of the platform only stood to a height of about 0.3 m below the bottoms of the slits (Ghezzi, 2016), and the surrounding defensive walls drop away in the easterly direction. In the case of Room 3 there was, in addition to a similar low platform-retaining wall, an eastern wall across the patio from the pillars. The calculations suggest with confidence that the top of this wall would have been no less than 0.2m below the bottoms of the slits on the pillars. Thus, all these pillars would have been able to catch the early morning sunlight.

Each day, during the few minutes following sunrise, a slowly changing pattern of sunlight beams shining through and between the pillars would have created a spectacular display on the dark back walls of both the long gallery of the atrium and the Room 3 gallery. Archaeoastronomical analysis supports the suggestion that the pillars were designed for the projection of spectacular lights and shadows, orchestrated to cover the whole year, accurately marking the solstices and equinoxes, and offering another type of calendar indicator at Chankillo. For further details see Section 2.b.4 Light-and-shadow hierophanies: the back walls and slitted pillars of the atrium gallery and Room 3 gallery within the Temple of the Pillars.

These solar hierophanies would have been observed by very few. Thus, the light-shadow casting devices offer insight into the social differences between the elite audiences at the very secluded Temple of the Pillars and Observatory Building and the more public Eastern Observing Point and Plaza solar alignments and corresponding ceremonies at Chankillo.

Unfortunately, these spectacular effects are no longer visible, both because the temple space is no longer enclosed and because most of the pillars with their slits have been destroyed.

The Keeps

The round towers (*torreones* in Spanish) of Chankillo are a defensive type of building known as a keep: a fortified tower within a fort, used as a refuge of last resort. While the astronomical use of the Thirteen Towers has inspired some to speculate on possible astronomical aspects in these dual round towers, these claims need further evaluation. A possible lunar alignment was identified (see Section 2.b.2 The viewshed from the entrance to the Temple of the Pillars to the distant mountainous horizon profile to the east). On the other hand, it is evident that the principles used in the strategic design of the Fortified Temple were applied in the design and defense of the keeps: high ground, concentric defensive compound walls, baffled gates paired to maximize protection, and wall top defenses accessed through interior stairways.

The keeps were built on the highest ground within the hilltop encompassed by the defensive walls of the Fortified Temple. They are formed by two concentric circular walls. The walls are compound: each has two joined sections, which at Chankillo is an attribute of defensive walls. Small stairs along the walls lead to the top, from which the keep could be protected. There are three left-turn baffled entrances in the outer wall and two in the inner wall. Like the monumental gates of the outer defensive walls, these entrances are paired or lined up with each other. Their doorways have niches for holding doors, and lintel roofs. The entrances are often simple ramps, although some had stairs (Figure 2-32, Figure 2-33). The existence of two identical and adjacent keeps might also be a strategic measure.

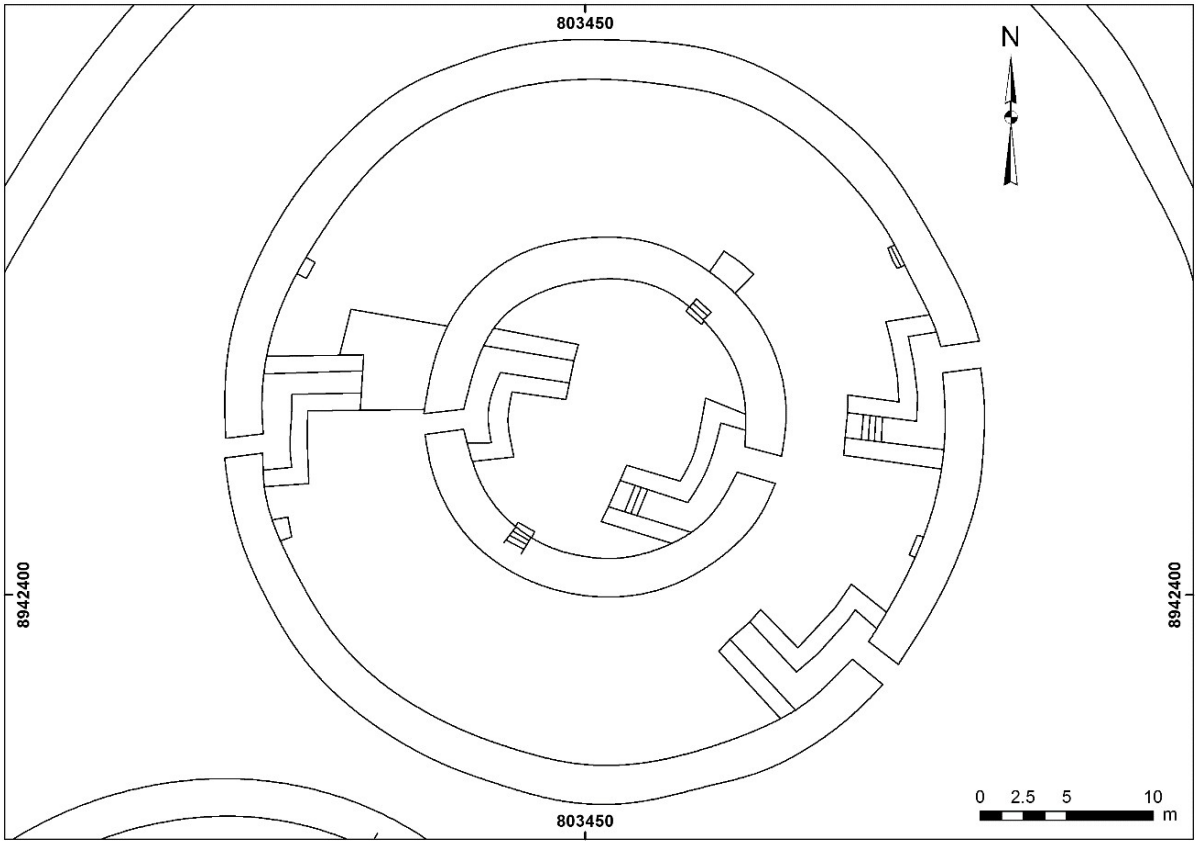


Figure 2-32. Ground plan of the North Keep

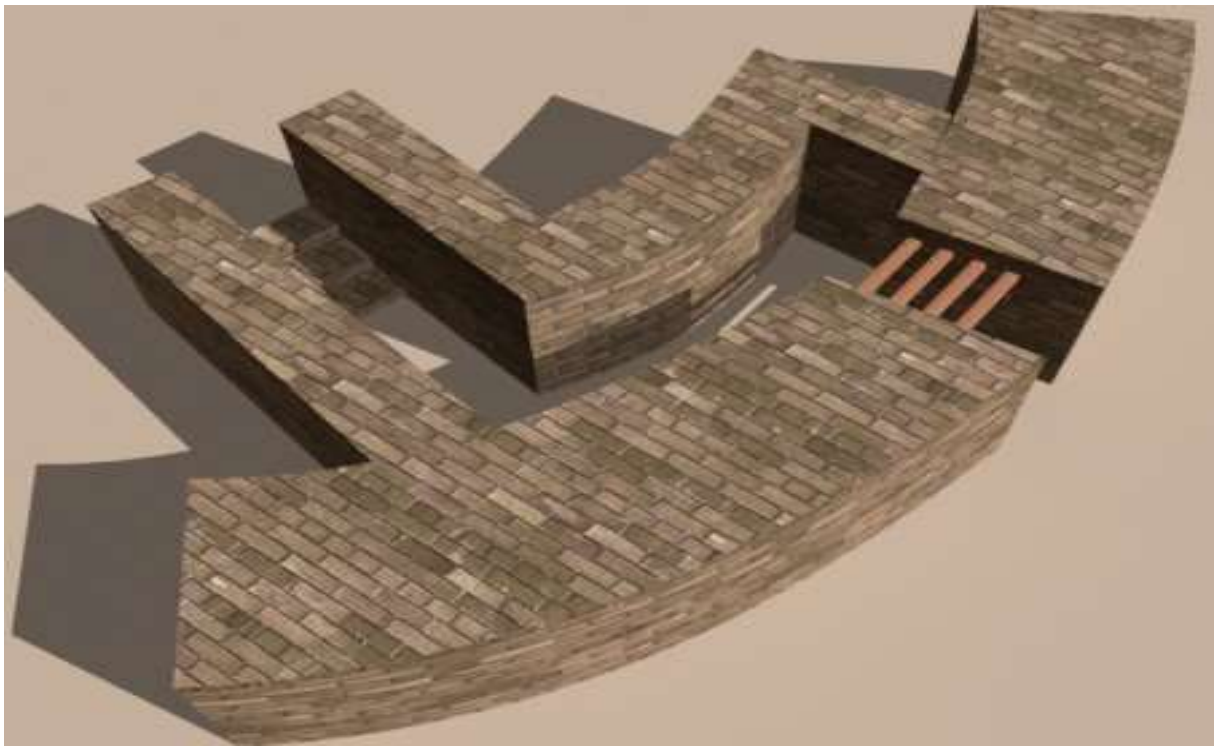


Figure 2-33. 3D model of the baffled entrances on the Keeps

2.a.1.c The Administrative Center

East of the towers is a 1.2 km^2-area of relatively flat but sloping sand ramps and exposed bedrock. Its main features are the Administrative Center, a large Plaza, and other minor buildings (Figure 2-34). This sector is interpreted as a public area with functions related to solar cult practices, redistribution, and feasting. Clusters of stone and lithic workshops indicate that the constructions were ongoing when Chankillo was abandoned. This is confirmed by excavations.

The Administrative Center (Building 3) is a large complex of platforms, patios, and rooms. At approximately 170 x 170 m, it is the second largest such complex at Chankillo. It is relatively well preserved, except for its perimeter wall, which was partially dismantled by recycling its stone after the abandonment of the site. Circulation patterns identify a lobby or entrance hall and several room complexes (Figure 2-35). The lobby is a longitudinal group of patios that organizes traffic across the building. The front center of the building has a single entrance. As much of the perimeter wall is missing due to stone robbing, it is uncertain whether this front entrance was the only one. It led to a large patio surrounded by a U-shaped platform, similar to the atrium of the Temple of the Pillars. Each part of the "U" has stairways facing the patio, located at either end. On the lateral arms of the "U" these stairs lead to the two front-room complexes. On its central dais, and also just like the Temple of the Pillars, the south stairways lead to a single entrance, which controls access to a maze-like four-room group connected by long corridors. Through a

baffled entrance, the maze leads to a secluded lobby in the back of the building with two large patios distributing traffic to two room complexes. Each complex is a closed group of interconnected rooms sharing one single entrance. In general, these rooms are smaller the farther they are away from the main entrance. Yet because of the terrain, they gain in elevation. The rooms are interconnected by dead-end corridors and baffled entrances; a majority are left-turn defensive baffles. The control of access gets progressively tighter towards the building´s interior.

South of this building there are dozens of large vessels buried in the ground. This was probably a facility for storing drinks, which would have been kept cool in this way.

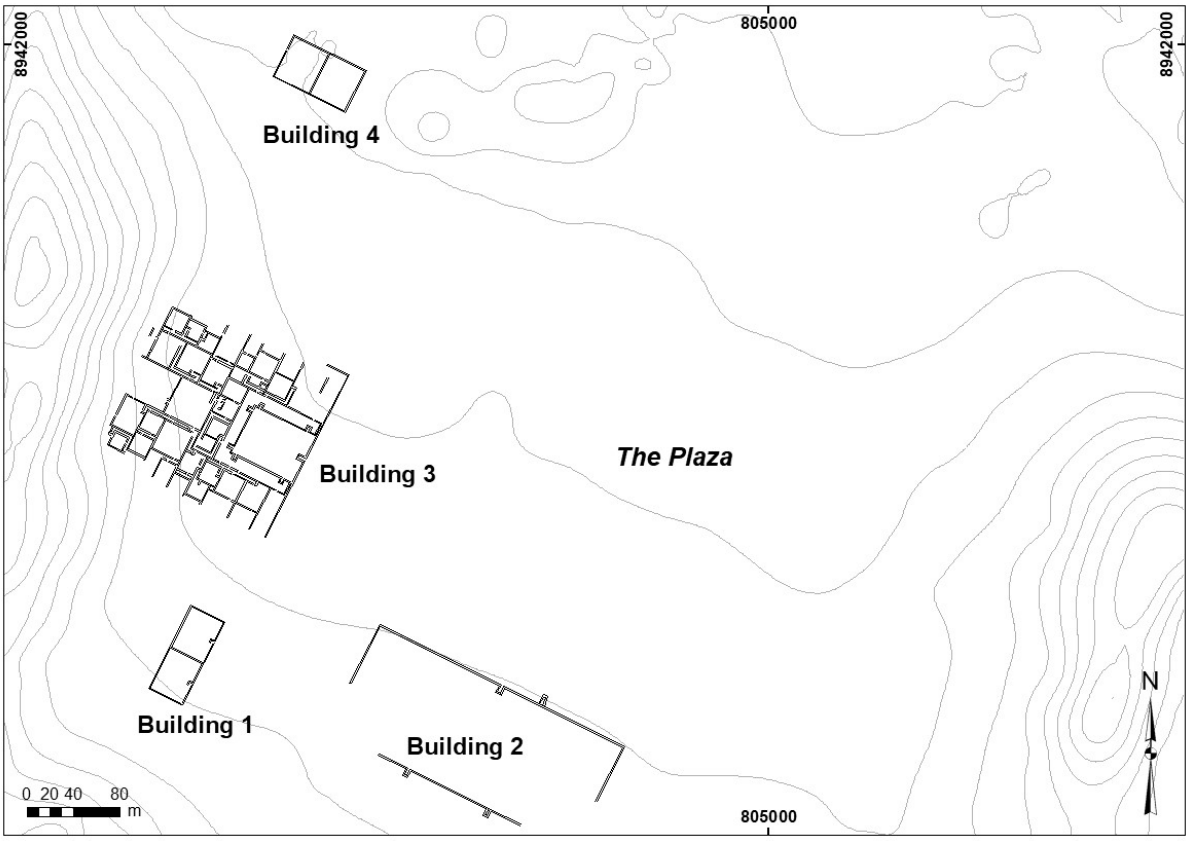


Figure 2-34. Administrative Center area

Figure 2-35. Subdivisions of the Administrative Center building according to transit patterns

Buildings 1 and 4 are rectangular, with two rooms (Figure 2-34). Most of Building 4 is buried by a dune. Its entrances are obscured, but excavations in Building 1 show that each room has a left-turning baffled entrance, and the rooms are interconnected through a doorway in the median wall. Building 2 is a large platform with incomplete retaining walls. Unlike the Administrative Center, where surface finds and excavations show some walls are missing due to stone robbing, this one is unfinished. The halt in construction most likely had to do with the site´s abrupt abandonment.

The Plaza is approximately 600 m by 400 m (Figure 2-34). Buildings 2 and 3 partially define it on two sides, yet the Plaza has no perimeter wall. However, there was an artificial modification of the terrain to create a space that is relatively flat and open compared to the surrounding terrain. There are offerings of *mullu* (Spondylus princeps sp.) and pottery panpipes around the Plaza, and the middens surrounding it have remains of utilitarian vessels, panpipes, and maize. The main features of Chankillo, such as the Thirteen Towers, the Fortified Temple, and the Administrative Center (Figure 2-20), stand out as the dominant elements of the built landscape visible from here.

A group of geoglyphs is found 700 m southwest of the Fortified Temple (Figure 2-36), another is 2.2 km away. Both are found along a natural route through the site, still in use, connecting the valley to La Gramita cove in the Pacific Ocean. They were created by piling up small fragments

of dark green andesite from nearby dikes over a light gray sand layer. This technique was used to create simple figures of triangles, circles, concentric circles, and rectangles. One of them, a circle surrounding a small square, resembles the circle-and-dot motif typical of Chankillo pottery. Their location, design, and associated pottery suggest these geoglyphs are contemporary with Chankillo and date to the late Early Horizon. The location of the first geoglyph group, away and apparently disconnected from the main monuments at the site, is revealing. In this built landscape, visibility may be as critical as distance in judging association (Moore 1996). Visibility maps reveal that these geoglyphs are found on the highest possible location of a small sliver of terrain visible from the Plaza, 2 km away. It has been suggested that flat elements such as geoglyphs mark the location of ceremonial processions or dances, and thus become visible from quite a distance (Lambers 2006). Similarly, the Chankillo geoglyphs could be a stage for ritual activities, in concert with solar cult ceremonies taking place in the Plaza.

Figure 2-36. Oblique photograph of the geoglyph group, during mapping

2.a.2 Cerro Mucho Malo

Cerro Mucho Malo is a rocky massif, 1180 masl in height, that forms part of the foothills of the western chain of the Andes Mountains on the Peruvian coast. Its exposed bedrock belongs to the Early Cretaceous. During the millions of years that have since elapsed there was substantial elevation of tectonic plates, fluvial and pluvial erosion in the area. There were also considerable fluctuations in the course and size of the river. But Cerro Mucho Malo is composed mainly of andesite rock, which is much harder than the surrounding tonalite rock that characterizes the Chankillo monumental archaeological zone, so the differential erosion explains why Cerro Mucho Malo is much higher in elevation, and why at this point the Casma River surrounds it, forming a sharp curve.

As noted in 2.a.1.b The Fortified Temple, the horizon to the east and southeast viewed from the Temple of the Pillars is low and distant. This is unique in the entire Casma region, and ideal for astronomical purposes, as it covers most of the solar rising arc (see Figure 2-26). On the other hand, as a result of the characteristics described above, Cerro Mucho Malo forms a nearby, high horizon to the ENE (Ghezzi and Guadalupe 2013); it can be seen forming the horizon at the point of June solstice sunrise in Figure 2-26. For this reason, its southern slope was used as a natural marker: as viewed from the Western Observing Point, its intersection with the artificial profile of the Thirteen Towers forms a continuous astronomical horizon that coincides with the range of sunrise positions throughout the solar year, with the intersection itself marking the position of the June solstice.

2.b Tangible manifestations of astronomy at Chankillo

In the previous section, various tangible astronomical elements at Chankillo were presented in their broader archaeological context. Here we describe the various astronomical viewsheds, sightlines and light-and-shadow displays, focusing upon the nature of these astronomical elements in themselves, including necessary technical detail, and their interrelationships.

These elements, which feature both constructed and natural sub-elements, can be summarized as follows:

1. The Chankillo Solar Observatory, composed of the Thirteen Towers and the Western and Eastern Observing Points, from which the towers profile spanned the annual sunrise and sunset arcs, respectively. These are the leading elements that make Chankillo unique and outstanding in a global context.

a) The viewshed from the Western Observing Point (WOP) to the Thirteen Towers together with part of Cerro Mucho Malo. The WOP, an open entranceway on the ESE side of the Observatory Building, is well attested archaeologically both as a viewing position and a location of considerable ceremonial importance accessible only to elite participants.

b) The viewshed from the Eastern Observing Point (EOP) to the Thirteen Towers. The EOP was a room or platform in an isolated small building in the plaza to the east, now largely destroyed but whose foundations partially survive.

2. The viewshed from the entrance to the Temple of the Pillars to the distant mountainous horizon profile to the east, which features a prominent horizon notch precisely at the position of equinoctial sunrise. Together with part of Cerro Mucho Malo, this profile includes the annual solar rising arc. It is a likely precursor for the later Observatory.

3. The viewshed from the WNW entrance of the Observatory Building to the Fortified Temple, which dominates the horizon in this direction. If, as seems likely, astronomical observations were also made from here, then the archaeoastronomical data suggest that they would have focused upon the setting moon.

4. The back walls and slitted pillars of the atrium gallery and Room 3 gallery within the Temple of the Pillars. Although the *in situ* physical evidence is largely destroyed, it is clear these would have produced a series of spectacular light and shadow effects during the minutes

following sunrise, orchestrated to span the entire year, with the slits producing particularly dramatic effects for a few weeks around the December solstice.

5. The sightline from certain limited areas in the plaza to the entrance to the Temple of the Pillars, a key position from which high-status individuals could have presided over ceremonials, but also where they would have stood in full view at the point of entry to (or emergence from) the Temple itself. From certain small areas in the plaza, Temple officials standing at the entrance could have been seen with the sun or moon setting behind them, thus providing a kind of "hierophany for the masses".

6. The solstitial axis connecting the Temple of the Pillars, the Observatory Building and the Administrative Center, which also passes through the gap between Towers 12 and 13, where the southern end of the line of towers bends round until it is perpendicular to this axis. The orientation of this site axis is followed to within 3° throughout Chankillo, resulting in the broadly solstitial alignment of all the principal buildings at the site.

Nature of the data underlying the archaeoastronomical conclusions

For archaeoastronomical purposes it is important to establish the relative locations of, and imperative to obtain accurate measurements of the true orientations between, different locations, both on the prehistoric site and in the natural landscape. It is also necessary to establish which points are intervisible and the nature of the visible horizon from different places, including the azimuths (bearings) and altitudes (vertical angle above or below horizontal plane of the observer) of horizon features. From these data, we can determine the (astronomical) declinations of horizon points, as described below, and from these declinations we can identify any astronomical bodies that rise or set there and would have done so at the time of construction and use. Generally speaking, it is desirable to specify orientations (azimuths and altitudes, hence declinations) to the nearest 0.1° (= 0° 6′), but it is not crucial to georeference the locations themselves to an accuracy exceeding about 1m.

The archaeoastronomical conclusions presented here are based on a combination of data from differential GPS surveys (2005, 2008) and Total Station surveys (2011, 2017), georeferenced using terrestrial (CyArk 2011) and aerial (LiDAR) laser-scanning data (Paz 2017). Specifically, the latter provided coverage of the core monumental archaeological zone at 1m x 1m resolution and of a wider area at 5m x 5m resolution. The raw digital surface model (DSM) data were processed in the commercial GIS (Geographical Information System) ArcGIS in order to remove spike anomalies, and then textured for display and analysis in the open-source program QGIS.

Features such as walls visible in the textured DSM then enabled the local grid system used for the site plan to be georeferenced to the LiDAR data. See Figure 2-37 for an example. Further details can be found in Ruggles (2017).

In the Total Station surveys, timed observations of the sun were used to determine true north at each station independently of other observations. This is standard practice in archaeoastronomy (see Ruggles 1999: 167–169) and enables us to take account of the difference between azimuths relative to the UTM grid (obtained, for example, when calculating orientations directly from the grid co-ordinates of two points) and those relative to true cardinal directions (needed when investigating the astronomical implications). The grid convergence (grid azimuth minus true azimuth) varies from +0° 27.5′ (at the Fortified Temple) to +0° 27.7′ (in the plaza). This is comparable to the apparent diameter of the sun or moon. Throughout this section, as throughout the document as a whole, quoted azimuths are true azimuths unless otherwise stated. Numerous consistency checks during the Total Station surveys established that all azimuth readings were consistent within 3′ (0.05°), i.e. 1/10 the apparent diameter of the sun or moon.

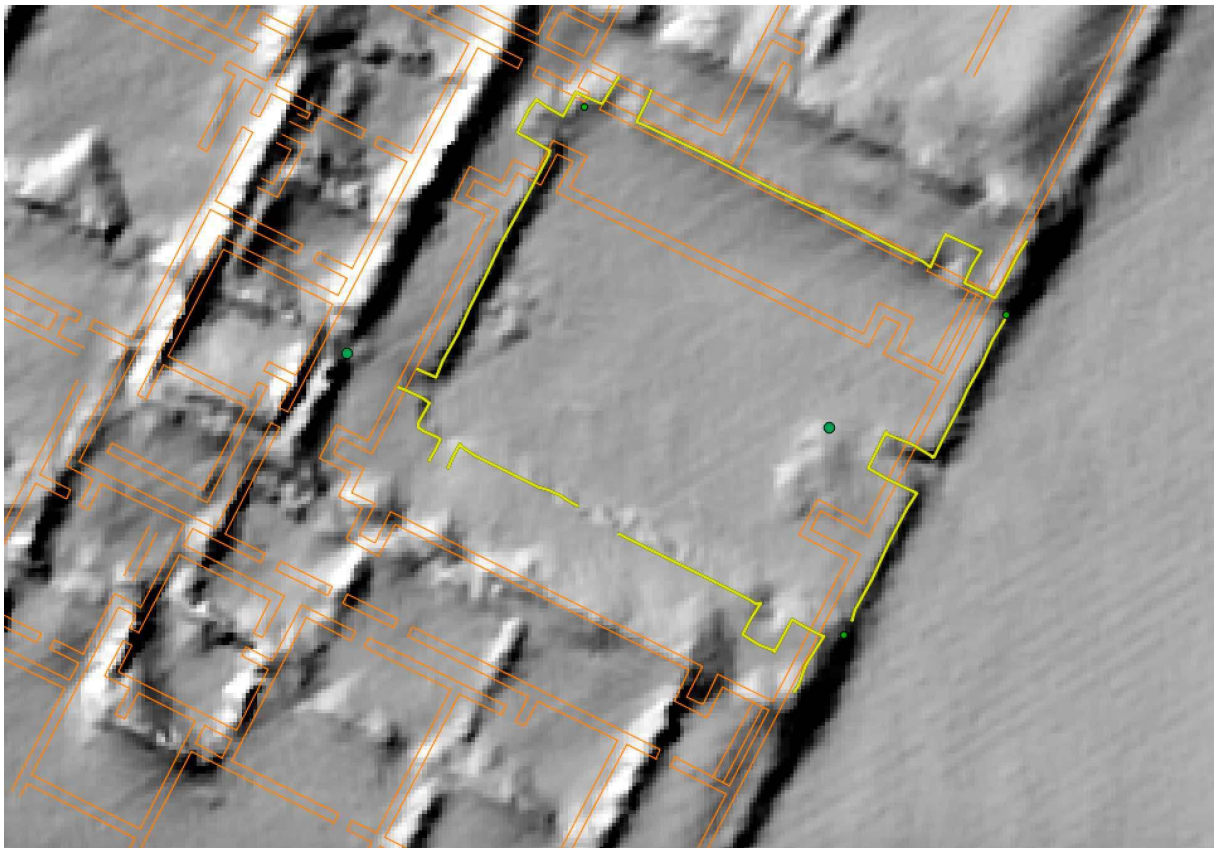


Figure 2-37. Part of the Administrative Center, showing rendered 1m-resolution DSM data with points (green) and lines (yellow) from the 2008 differential GPS survey superimposed. The orange lines are from the 2015 laser-scanning data, uncorrected. The discrepancy requires a correction of approximately 7m to the E and 6m to the N.

Declination is equivalent to latitude on the rotating celestial sphere. The declination of the north celestial pole is +90°, that of the south celestial pole –90°, and that of the celestial equator 0°. Each day a "fixed" celestial object such as a star moves around the sky (above and below the horizon) on a line of declination. The declinations of the sun, moon and planets change gradually on a day-to-day basis, being the most marked in the case of the moon. The declination of the sun varies on a seasonal basis—nowadays between ±23.45° and around 200 BC between ±23.75°. Thus, at the time of construction and use of Chankillo, the solar disc (0.5° wide) spanned declinations +23.5° to +24.0° at the June solstice and –24.0° to –23.5° at the December solstice.

GIS tools permit the visualization of topographic data and viewsheds, e.g. Figure 2-42 (a), produced in QGIS. In addition, horizons and their astronomical potential can be visualized in several ways, such as:

- from photographs taken on site, marked up with the azimuths, altitudes and declinations of particular points as determined from the site survey (Figure 2-41);
- by digitally generating the view from the DSM data, annotated as required with grids of azimuths and altitudes, declinations, and/or the horizon rising and setting lines of celestial bodies, e.g. using the HORIZON program produced by Dr. Andrew Smith of the University of Adelaide, Australia (www.agksmith.net/horizon/) (Figure 2-40);
- using the sky visualization program Stellarium (stellarium.org), which can be configured to show the sky at any point in time and into which horizon photographs and topographic models can be imported and integrated (e.g. Figure 2-26).

2.b.1 The Solar Observatory

2.b.1.a The viewshed from Western Observing Point (WOP) to the Thirteen Towers together with part of Cerro Mucho Malo

The WOP and the configuration of the towers as viewed from it is the leading element that makes Chankillo unique and outstanding in a global context. As noted in Section 2.a.1.a The Chankillo Solar Observatory, the WOP was an open doorway offering an unimpeded view of the towers and their surroundings; around it was excavated a scattering of votive offerings, indicating that this was a place of considerable ritual importance.

The SSW corridor of the Observatory Building, along which the WOP was approached, follows the orientation constraints of the overall grid (see below Section 2.b.6 The “site axis” and the broadly solstitial site alignment of all the principal buildings at the site). As a result, it is oriented some 7° to the right of the right-hand side of Tower 13, and consequently the impactive profile

of the towers would have remained hidden to someone walking along the corridor until they came very close to the opening itself, surely adding to the sense of veneration at this spot.

As seen from here, the towers themselves are well above the observer and dominate the eastern horizon. The southern slopes of Cerro Mucho Malo, at a distance of 3 km, meet the much closer ridge on which the towers are constructed just to the left of the northernmost tower, Tower 1. The visual effect is to provide a "thirteenth gap" of similar width to those between each pair of adjacent towers down the line.

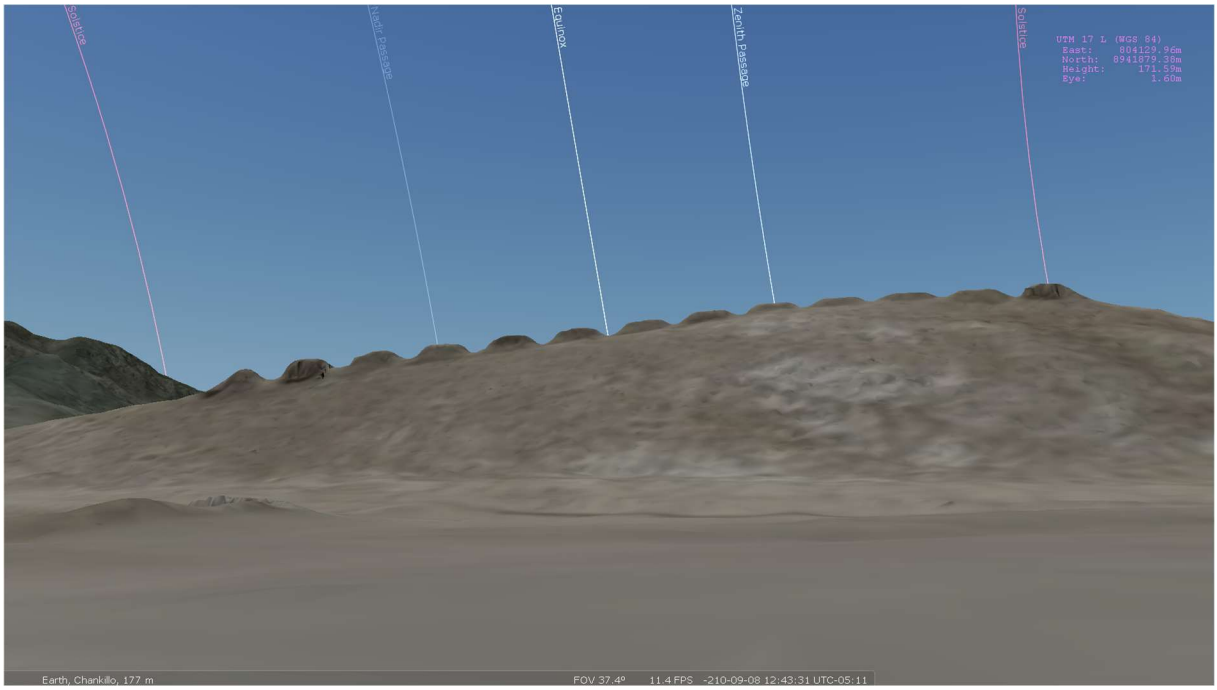


Figure 2-38. The towers profile to the east as viewed from the WOP, showing the paths of sunrise at the solstices, equinoxes, and the days of zenith and antizenith passage. Visualization produced in Stellarium

As the sun reached the southernmost limit of its annual passage, at the December solstice, it would have been seen from here to rise directly up from the top of the southernmost tower, Tower 13 (Figure 2-38). At its northernmost limit, at the June solstice, it rose from Cerro Mucho Malo to the left of the "thirteenth gap". The position of sunrise progressed up and down the towers at intermediate dates, mostly appearing for just one or two days in each gap and then for a period of around 10 days between them but slowing down closer to the solstices. This device permitted the time of year to be accurately determined, not just on one date but throughout the seasonal year.

Table 2-2 summarizes the archaeoastronomical data for the towers profile as viewed from the WOP. Further details on the survey methods and errors can be found in Ruggles (2017).

Table 2-2. The azimuths, altitudes and declinations of the towers profile as viewed from the WOP. The values are based on measurements of those tower corners that define the "gaps" and refer to the lowest visible point of the wall in each case.

Point	True azimuth	Altitude	Declination
Cerro Much Malo	64.3	6.6	+24.0
Junction between Cerro Mucho Malo and local horizon	66.0	5.9	+22.6
T1 left	66.4	6.0	+22.1
T1 right	69.2	6.7	+19.2
T2 left	69.9	6.7	+18.5
T2 right	72.8	7.5	+15.5
T3 left	73.5	7.6	+14.9
T3 right	76.5	7.8	+11.9
T4 left	77.2	8.1	+11.2
T4 right	80.3	8.5	+8.1
T5 left	81.0	8.5	+7.3
T5 right	84.1	9.1	+4.3
T6 left	84.9	9.1	+3.5
T6 right	88.0	9.9	+0.4
T7 left	88.8	9.6	–0.4
T7 right	91.8	10.5	–3.5
T8 left	92.6	10.2	–4.2
T8 right	95.6	11.0	–7.2
T9 left	96.3	10.7	–7.9
T9 right	99.0	11.0	–10.6
T10 left	100.0	11.1	–11.6
T10 right	103.0	11.2	–14.4
T11 left	103.7	11.8	–15.2

T11 right	106.8	11.1	–18.2
T12 left	107.6	11.1	–18.9
T12 right	110.5	11.2	–21.8
T13 left	111.3	10.8	–22.5
T13 right	113.9	11.2	–25.1

The fact that the equinox sun rose in a narrow gap (between Towers 6 and 7), as is evident both from the figure and the table, supports the idea that the tower profile was a constructed reflection and elaboration of earlier observations using the natural horizon (see section 2.b.2 The viewshed from the entrance to the Temple of the Pillars to the distant mountainous horizon profile to the east). This unique and remarkable example of a monumental solar horizon calendar is entirely practical in nature. Even though the interval of time between the sun's appearance in successive gaps is around 10 days in most cases, this time interval increases towards the solstices, and there is no evidence to suggest that specific divisions of time were being deliberately marked or were conceived as important. In particular, there is no evidence to suggest that either the dates of "zenith sunrise" (sunrise on the days when the sun will reach the zenith at noon, which occur when the declination of the sun is equal to the latitude of the site, i.e. –9.55°) or those of "antizenith sunrise" (sunrise on the days when it reached the nadir at midnight, which occurs when the declination of the sun is equal to the minus the latitude of the site, i.e. +9.55°) were of any particular cultural significance at Chankillo, although they are thought to have been significant during much later Inca times(43)(*43*) (Zuidema 2014:857–858).

2.b.1.b The viewshed from the Eastern Observing Point (EOP) to the Thirteen Towers

There is only one small area on the site from which the Thirteen Towers on the skyline to the west span the sunset arc. The fact that this coincides with the position of an isolated small building is significant in itself, and the fact that the June solstice sun would have been seen from here to set into the top of the northernmost tower, Tower 1 (Figure 2-39), just as from the WOP the December solstice sun rose from the center of the southernmost tower, Tower 13—thus following principles of symmetry evident elsewhere on the site—strongly supports the supposition that this was indeed a viewing point for the setting sun against the towers, even though its importance is less well attested archaeologically.

Figure 2-39. The towers profile to the west as viewed from the EOP, showing the paths of sunset at the solstices, equinoxes, and the days of zenith and antizenith passage. Visualization produced in Stellarium

The line of towers towards the south bends away from an observer at the EOP and disappears over the hill, unlike the situation at the WOP where the southernmost towers bend round to face the observer. As a result, there are no visible gaps between the southernmost four towers, and Tower 13 would not have been visible at all: thus while the December solstice sun set in the direction of this tower, the leftmost limit of the solar arc did in fact occur over natural terrain rather than a tower, in common with the eastern profile from the WOP and arguably manifesting another symmetry between the western and eastern profiles. The azimuths and altitudes of the towers profile as viewed from the EOP are summarized in Table 2-3. Further details on the survey methods and errors can be found in Ruggles (2017).

Table 2-3. The azimuths, altitudes and declinations of the towers profile as viewed from the EOP. The values are based on measurements of those tower corners that define the "gaps" and refer to the lowest visible point of their walls. There are no gaps between towers further to the south

Point	True azimuth	Altitude	Declination
T1, right	297.2	7.5	+25.2
T1, left	294.6	8.3	+23.0
T2, right	294.2	8.9	+22.0
T2, left	291.0	9.4	+18.8
T3, right	290.4	10.1	+18.0
T3, left	287.3	10.3	+15.0
T4, right	286.4	10.7	+14.1
T4, left	283.2	11.0	+10.9
T5, right	282.1	11.6	+9.7
T5, left	278.2	11.9	+5.9
T6, right	276.9	12.2	+4.6
T6, left	274.5	12.9	+2.2
T7, right	272.1	12.7	–0.1
T7, left	269.7	13.8	–2.5
T8, right	268.9	13.5	–3.2
T8, left	265.2	14.3	–6.9
T9, right	264.6	14.1	–7.5
T9, left	260.6	14.7	–11.4
T10, right	260.4	14.3	–11.5

2.b.2 The viewshed from the entrance to the Temple of the Pillars to the distant mountainous horizon profile to the east

A digital visualization of the eastern horizon, as viewed from the entrance to the Temple of the Pillars is shown in Figure 2-26. Figure 2-40 shows the same profile as generated from publicly available SRTM data using the HORIZONS program developed by Dr A. Smith of the University of Adelaide, suitably "ground-truthed" using direct measurements taken during the Total Station

surveys. In this figure the horizon features are overlaid with a grid marking the azimuths, altitudes and declinations, although small horizon features do not show up so clearly.

Regarding the principal "stations of the sun":

- June solstice sunrise occurred over Cerro Mucho Malo close to, but not quite at, a slight dip at az. 65.4°. The solstitial sunrise occurred at little to the left, at az. +64.3° to +64.8°. The declination of the dip itself is +22.8°, corresponding to sunrise around Jun 4–8 and Jul 6–10 (in the Gregorian calendar).
- December solstice sunrise occurred at an easily identifiable point on the horizon, a discernible dip to the left of a small isolated peak at azimuth 114°. This dip has az. 113.6°, alt. 3.6° and dec. +23.8°, so the December sun would have risen directly out from this dip.
- A prominent dip in the distant mountainous horizon to the east, forming the lowest point on this distant ridge, coincides with sunrise at the two equinoxes. The bottom of the dip has declination –0.15°: at the astronomical equinox, the sun spans declinations –0.25° to +0.25°.
- There is no obvious point on the horizon marking "zenith sunrise" (sunrise on the days when the sun passes across the zenith at noon, an event of significance among various tropical cultures in the Americas), at dec. –8.55°.

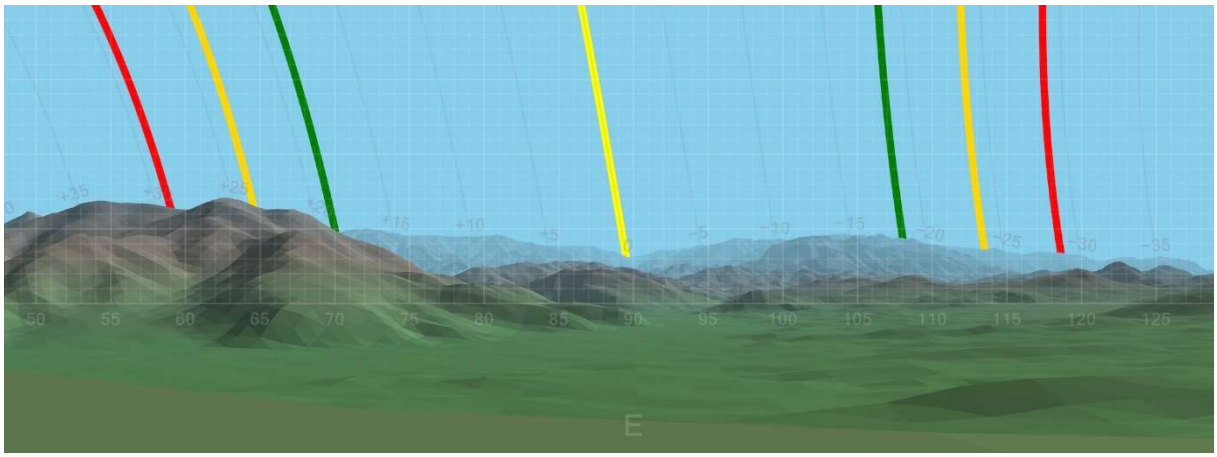


Figure 2-40. Digital visualization of the eastern horizon as viewed from the entrance to the Temple of the Pillars. The grids show azimuth, altitude and declinations marked in degrees. The yellow lines show the rising paths of the sun at the June solstice (left), equinoxes (center) and December solstice (right) in the 3rd century BC. The red and green lines show the major and minor standstill limits for the moon (not relevant for this discussion).

Regarding other prominent features on the horizon itself:

- At azimuth 103°–105° there is a prominent "half-moon"-shaped dip within the highest part of the distant horizon, with yet more distant horizon rising to a rounded peak beyond. This has attracted attention as a possible foresight. The declination range, –13.5° to –15.2°, corresponds to sunrise between approx. Feb 7–12 and Oct 27–Nov 1 (Gregorian).
- At azimuth 106.5°–107.5°, again within the highest part of the distant horizon, there is feature resembling a stepped pyramid, which has also attracted attention as a possible foresight. The declination range here, –17.0° (peak) down to –17.8° (bottom of right-hand slope), corresponds to sunrise between approx. Jan 29–31 and Nov 8–10 (Gregorian).

In any natural horizon used as a solar horizon calendar, the position of features and foresights available to provide accurate markers of sunrise on certain dates are positioned, in effect, randomly, although the dates when the sun rises behind them may acquire cultural significance as a consequence (Ruggles 2014:24–25). In the case of Chankillo, the most prominent horizon notch coincides precisely at the position of equinoctial sunrise as viewed from the entrance to the Temple of the Pillars. Notwithstanding that there is much specialist discussion about the precise definition and cultural significance of the equinox (Ruggles 2017), it strongly suggests that this location acquired cultural significance as the appropriate viewing point, and was therefore chosen as the site of the Temple of the Pillars.

It is also likely that this spectacular mountainous profile, with a variety of other features that would have provided natural foresights marking the changing rising position of the sun, provided a precursor of, and inspiration for, the construction and use of the towers for this purpose.

2.b.3 The viewshed from the WNW entrance of the Observatory Building to the Fortified Temple

The Observatory Building (OB) had an entrance facing WNW, symmetrical with the WOP facing ESE. The adjacent later building, Structure 5 (here referred to as "OB2") is also likely to have had an entrance facing WNW, although that part of the structure has been destroyed. Symmetry principles operating elsewhere on the site suggest the possibility that astronomical observations were also made from the OB entrance or both entrances.

The WNW entrances to the two buildings faced the Fortified Temple, which stands out prominently on the horizon. Figure 2-41 shows the profile as seen from the OB entrance. The NNE wall of the OB (az. 301.7°) is aligned upon the center of the circular Southern Keep (az. 301.8°) as seen from the WNW entrance. Similarly, that of OB2 (az. 300.8°) is aligned upon the

center of the circular Southern Keep as seen from its entrance (az. 301.0°). However, the declination (+29.0° from OB1NW, +27.7° from OB2NW) is well outside the solar range.

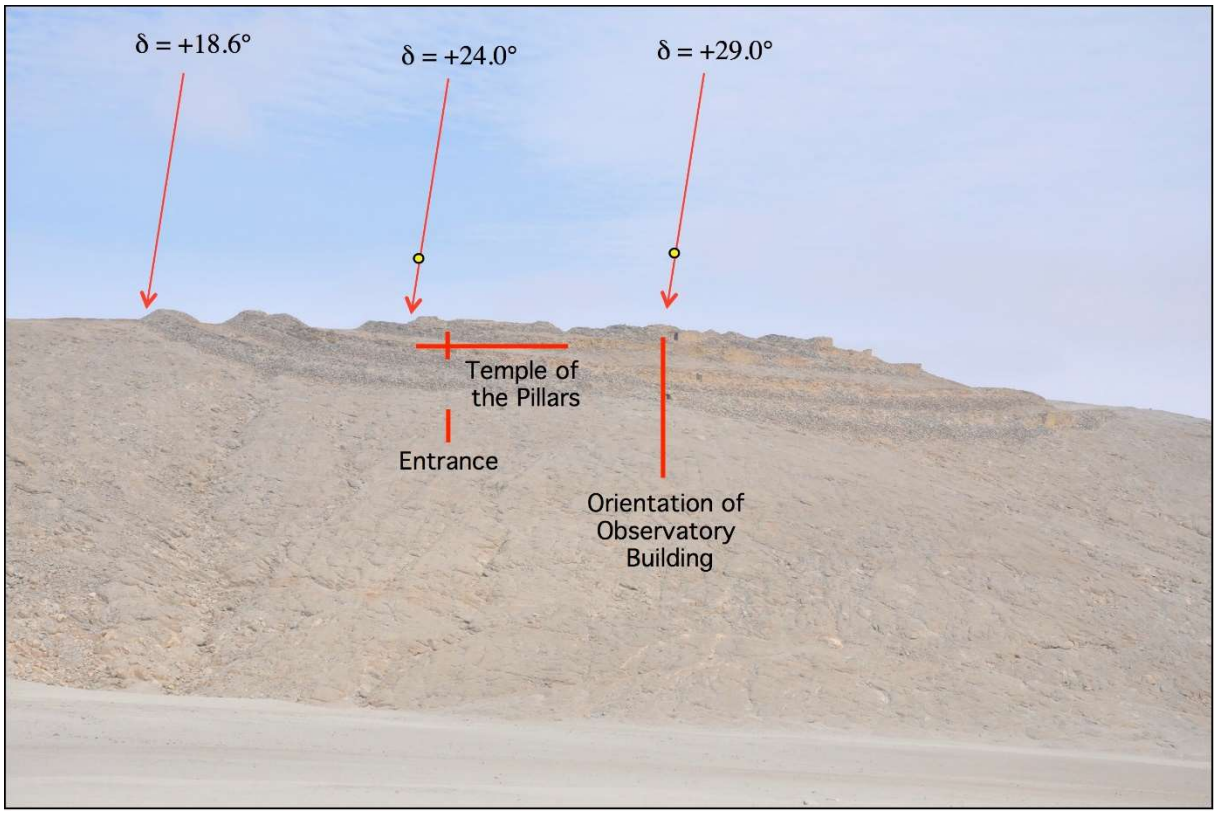


Figure 2-41. The Fortified Temple on the skyline as viewed from the WNW entrance of the Observatory Building. The annotations show the orientations of the NNE and SSW walls of the OB and the declinations of certain points on the profile.

In fact, a 2nd-century-BC viewer standing at the OB entrance in the late afternoon at the June solstice would have seen the sun above the southern wall of the Temple of the Pillars moving slightly to the left while descending, eventually setting into the gap immediately to the left of the Temple. The right-hand side of the solar disc, at declination +24.0°, would just have touched the base of the outer side of the Temple's southern wall. At all other times of year, the sun would have set further to the south: in other words, it would never (quite) have been seen to set behind the Temple itself.

The declination of the Southern Keep does, however, correspond closely to the theoretical northernmost setting point of the moon (δ = +28.9° around 200 BC, falling slightly to +28.6° by the early 2nd millennium AD). While the rising or setting position of the moon (unlike that of the sun) changes a great deal from day to day (further complicated by the moon's changing phases), the significance of this is that the full moon close to the December solstice, towards which the

Chankillo site is broadly oriented, would have set as far north as this in favorable years within the 18.6-year lunar node cycle (a time known technically as the "major lunar standstill").

Added to this, the declination of the foot of the outer side of the outer enclosing wall as seen from the entrance to the OB, +18.6°, corresponds almost exactly to the northern minor standstill limit (+18.6° around 200 BC, falling slightly to +18.3° by the early 2nd millennium AD). This limit (being the minimum of the monthly maximum limits of the moon's motions over the course of an 18.6-year lunar node cycle) is extremely unlikely to have had cultural meaning in itself outside a modern Western cultural context (Gonzales-García 2014), but the fact that the highest part of the Temple profile spans the range between the northern major and minor standstill limits could be significant. This represents the range of positions (over an 18.6-year node cycle) where the full moon would have been seen to set at dawn around the time of the December solstice, the very time when the sun would be seen to rise out of the top of Tower 13 as viewed from the opposite entrance (WOP). Most often, the full moon would have been seen to set close to the Southern Keep (at around the time of the major standstill) or close to the outer walls (at around the time of the minor standstill) rather than towards the center of the range.

It cannot be proved that these alignments were deliberate, but they do highlight the possibility that sunrise observations from the WOP were preceded or accompanied by observations of full moonset over the Fortified Temple from the opposite entrance. Ceremonies held at the full moon nearest a solstice, combining observations of the rising sun and of the setting full moon, are documented in other cultures (Ruggles 2014). At Chankillo, it is likely that ceremonies relating both to the sun and moon took place at the full moon nearest the December solstice.

2.b.4 Light-and-shadow hierophanies: the back walls and slitted pillars of the atrium gallery and Room 3 gallery within the Temple of the Pillars

As described in Section 2.a.1.b The Fortified Temple, the slitted pillars lining the galleries at the back of the atrium and Room 3 in the Temple of Pillars faced the eastern horizon directly, unblocked by intervening walls. In the darkened spaces of the pillared galleries the early morning sunlight, shining in between the pillars and (at certain times of year) through the slits, would have created a spectacular display on the back walls.

Sunlight on the back walls

If the roof of the long gallery in the atrium was 2m high and that it extended beyond the front of the platform, then it would have measured some 7.5m from front to back. If so, then once the sun's altitude exceeded about 15°, sunlight could not reach the back wall. In the case of the gallery

in Room 3, assuming a height of 2m and an extent about 10m from front to back, this would have been true once the sun reached an altitude of about 11°.

At Chankillo the sun reaches an altitude of 11° approximately 20–30 minutes after sunrise, and an altitude of 15° approximately 40–50 minutes after sunrise, depending upon the time of year (Table 2-4). Thus, we estimate that for around 25 minutes after sunrise each morning during the year, sunlight would have been low enough to light the back wall of the gallery in Room 3; while for around 45 minutes it would have been low enough to light the back wall of the long gallery in the atrium. If a given roof extended out further, the length of time during which sunlight could have struck the corresponding back wall would have been somewhat less; if the gallery roof was higher it would have been somewhat greater.

Table 2-4. Estimated time intervals during which sunlight could have reached the back walls of the pillared galleries in Room 3 and the atrium, obtained by combining data from Stellarium and the horizon data generated from the digital terrain models. The calculations are performed for the 3rd century BC, although the change in the sun's position over the centuries is very small.

	Sunrise			End of interval when sunlight can reach the back wall of the pillared gallery in...					
				Room 3			The atrium		
	Time (UT–5)	Az.	Alt.	Time (UT–5)	Az.	Alt.	Time (UT–5)	Az.	Alt.
June solstice	06:55	64.6°	6.6°	07:15	63.5°	11.0°	07:33	62.2°	15.0°
Equinoxes	06:33	89.5°	3.2°	07:05	88.1°	11.0°	07:21	87.4°	15.0°
December solstice	06:13	113.4°	3.6°	07:46	112.5°	11.0°	07:04	112.1°	15.0°

On days around the December solstice, when the sun rose close to the direction faced by the Temple (119.0°) and at altitude of 3.6°, the effect in both galleries would have been to create vertical stripes of light and shade of more or less equal width (1.0m), extending up the back wall to about 0.45m from the top in the case of the long gallery in the atrium, and about 0.65m in the case of the Room 3 gallery. If the height of the platform retaining wall (front wall) was no more than 0.45m above the floor in the case of the long gallery in the atrium, or 0.65m in the case of the Room 3 gallery, then even at altitude 3.6° the sun would already have been high enough for sunlight to reach to the bottom of the back wall. Otherwise, the bottom of the wall would have remained in darkness at this point.

As the sun rose in the sky and moved slightly to the left, the top of the lit stripes would gradually have descended the wall. At the same time, they would have narrowed somewhat (while their centers remained equally far apart) and moved slightly to the left. They would also have extended further down onto the floor.

At other times in the year, the height of the bright stripes at first glance would have varied slightly because of the variation in the altitude of the distant eastern skyline (Figure 2-26), from a minimum of 3.2° at the equinoxes to a maximum of 6.6° at the June solstice. A more noticeable difference would have occurred because sunlight now entered the galleries from a direction no longer perpendicular to the back walls and lines of pillars. The width of the bright stripes would have been noticeably narrower. The changes over the year are presented in Table 2-5.

Table 2-5. Parameters of the striped patterning of sunlight and shade on the back walls of the long gallery in the atrium and the Room 3 gallery during the minutes around dawn at different times of year (as determined by the azimuth of the sun, see Table 2-3). In both cases the pillars are assumed to have width 1.0m and thickness 0.8m and to be spaced 1.0m apart.

Azimuth faced by temple (°)	119.0	119.0	119.0	119.0	119.0	119.0
Azimuth of sun (°)	110.0	100.0	90.0	80.0	70.0	65.0
Horizontal angle between direction of sunlight and direction perpendicular to wall (°)	9.0	19.0	29.0	39.0	49.0	54.0
Width of bright stripes (m)	0.9	0.8	0.6	0.4	0.2	0.0
Width of dark stripes (m)	1.1	1.2	1.4	1.6	1.8	2.0
Mean displacement along wall (m): Long gallery in the atrium	0.4	1.1	1.9	2.8	4.0	4.8
Room 3 gallery	0.4	1.1	1.8	2.7	3.8	4.6

Whether by accident or design, the width of the bright stripes shrinks to zero more or less exactly at the time of the June solstice. In other words, the width of the bright stripes offered another calendrical indicator, simple and direct, that operated throughout the year.

Furthermore, at the equinoxes the displacement of the stripes was almost exactly equal to the distance from one pillar (or space) to the next, meaning that a viewer looking directly into the back gallery from the atrium or Room 3 patio would have seen the bright stripes on the back wall aligning in the gaps between the pillars. This only happened around the December solstice (no

displacement), the equinoxes (displacement by one pillar) and the approach to the June solstice (displacement by two pillars), by which time the stripes would have been very narrow. At other times the bright stripes would have been partially or completely hidden behind the pillars.

The effect of the slits

Around the December solstice, each 1m-wide dark stripe would have additionally contained three bright rectangles produced by sunlight passing through the three slits in the pillar concerned. These would have been most pronounced at the moment of sunrise on days very close to the solstice, when the sun would have shone more or less directly through the slits, producing full-size (20 cm x 8 cm) rectangles of light on the walls behind. As the sun rose in the sky the slits would have decreased in height (and slightly in width) as well as descending the walls.

A few days after the solstice, the images of the slits would have become noticeably narrower, as sunlight began to enter the galleries at a significantly oblique angle. For the central, 77cm-long, slit, once this horizontal angle had exceeded 5.9°, sunlight was no longer able to penetrate the length of the slit. For the side slits, where the incision may have decreased the effective length to, say, 70cm, the angle was about 6.5°. This occurs when the sun's azimuth falls below about 110°, which happens around 30 days either side of the December solstice. In other words, the pattern of “bright patches” caused by the slits would only have been visible for about a 2-month period around the December solstice.

Discussion

The fact that the width of the bright stripes shrinks to zero more or less exactly at the time of the June solstice, and that the bright stripes align in the gaps between the pillars at the December solstice and equinoxes, considerably strengthens the idea that the light and shadow effects were intentional, and indeed purposefully orchestrated to span the entire year. The importance of the December solstice would have enhanced by the appearance, about a month before the actual date, of the sets of three bright patches in each pillar shadow, widening to their maximum at the solstice itself. These hierophanies (spectacular displays accorded sacred significance) could have offered another type of calendrical indicator at the Chankillo complex, accessible only to those permitted to enter the Temple.

Sadly, these spectacular effects are not visible today, both because the temple space is no longer enclosed and because most of the pillars with their slits have been destroyed.

2.b.5 The sightline from certain limited areas in the plaza to the entrance to the Temple of the Pillars

The entrance to the Temple of the Pillars offered a fine view of much of the Chankillo site. It was a key position from which high-status individuals could have presided over ceremonials, but also where they would have stood in full view at the point of entry to (or emergence from) the Temple itself. The archaeoastronomical evidence suggests that the entrance point was positioned so that, with appropriate timing, the Temple officials could have been seen with the sun (or other celestial body) setting behind them, thus providing a sort of "hierophany for the masses".

The part of the plaza visible from the entrance, and conversely from which the entrance could be seen, is shown in Figure 2-42 (a). Figure 2-42 (c) shows the view towards the entrance from a typical point on this part of the plaza, with the towers on the foreground ridge and the Temple and its entrance on the more distant ridge behind. The scatter of points marking the edge of the visibility envelope (points from which the entrance to the Temple of the Pillars is just visible) traces out a jagged profile formed by the sharp edges of the towers and the gaps between them moving in relation to the Temple and its entrance. The "shadow" of the towers extends somewhat further (generally by about 10–15m) eastwards than the boundary line generated by the ground survey. This is because the viewshed was based on the eye-height of an observer at the entrance of the Temple of the Pillars looking down over the plaza, whereas the ground survey was based on that of an observer on the plaza looking up at the Temple, which is more relevant here.

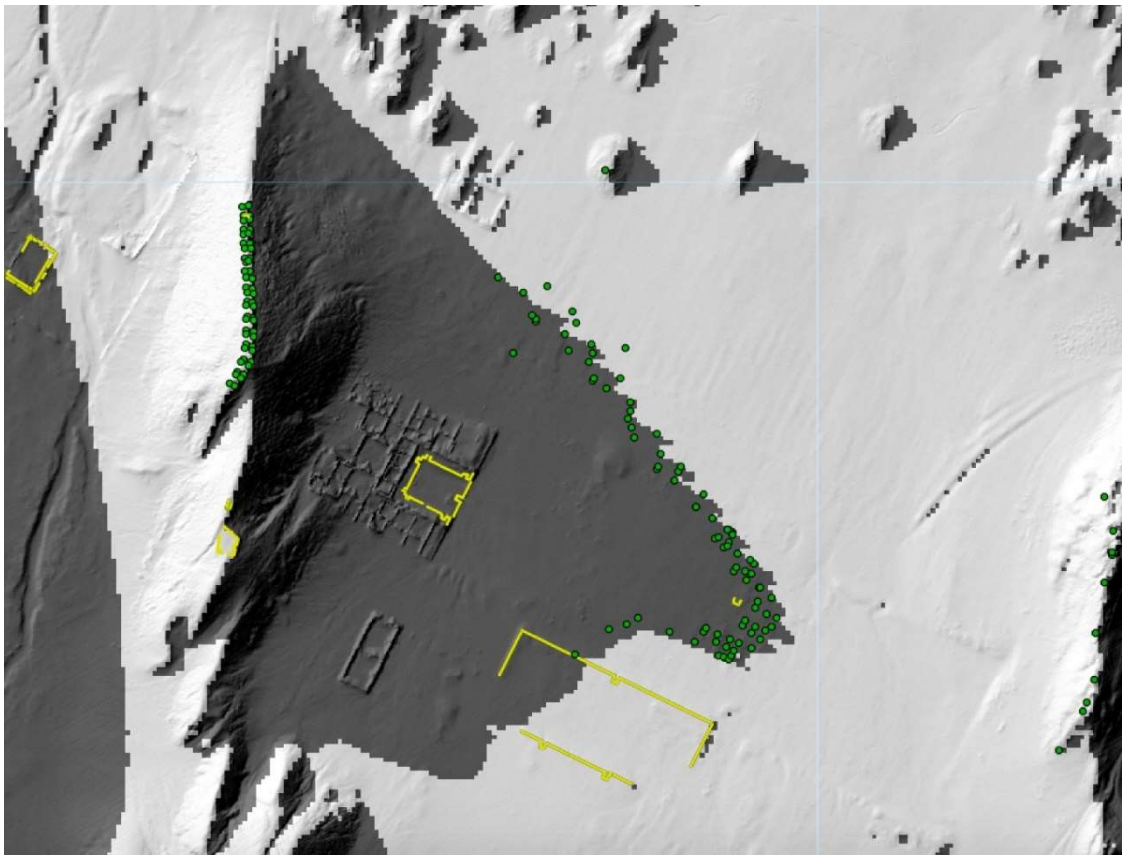
The saw-tooth shape of the boundary is most evident in the vicinity of the "shadow" of the southernmost towers Figure 2-42 (b). It is also especially evident in this area that unexcavated features (showing as bumps in the DSM) seem to avoid the area from which the Temple entrance was hidden by the ridge containing the towers. Possible structures, on the other hand, appear to be concentrated along the boundary and just outside it, especially in the vicinity of the "shadows" of Towers 13 and 12. Regardless of the astronomical possibilities, this in itself suggests that it was important for such structures either to be within sight of the Temple entrance or to have the Temple entrance within view. The correlation is much sharper in relation to the surveyed points than to the viewshed boundary, suggesting that it was the view to, rather than from, the Temple entrance that was important.

Figure 2-42 (a) also shows a large area cleared for future construction, approximately 200m square, directly to the ESE of the area just discussed, broadly in line with the administrative building. This lies (just) outside the visibility shadow, meaning that anything built here would also have been intervisible with the Temple entrance.

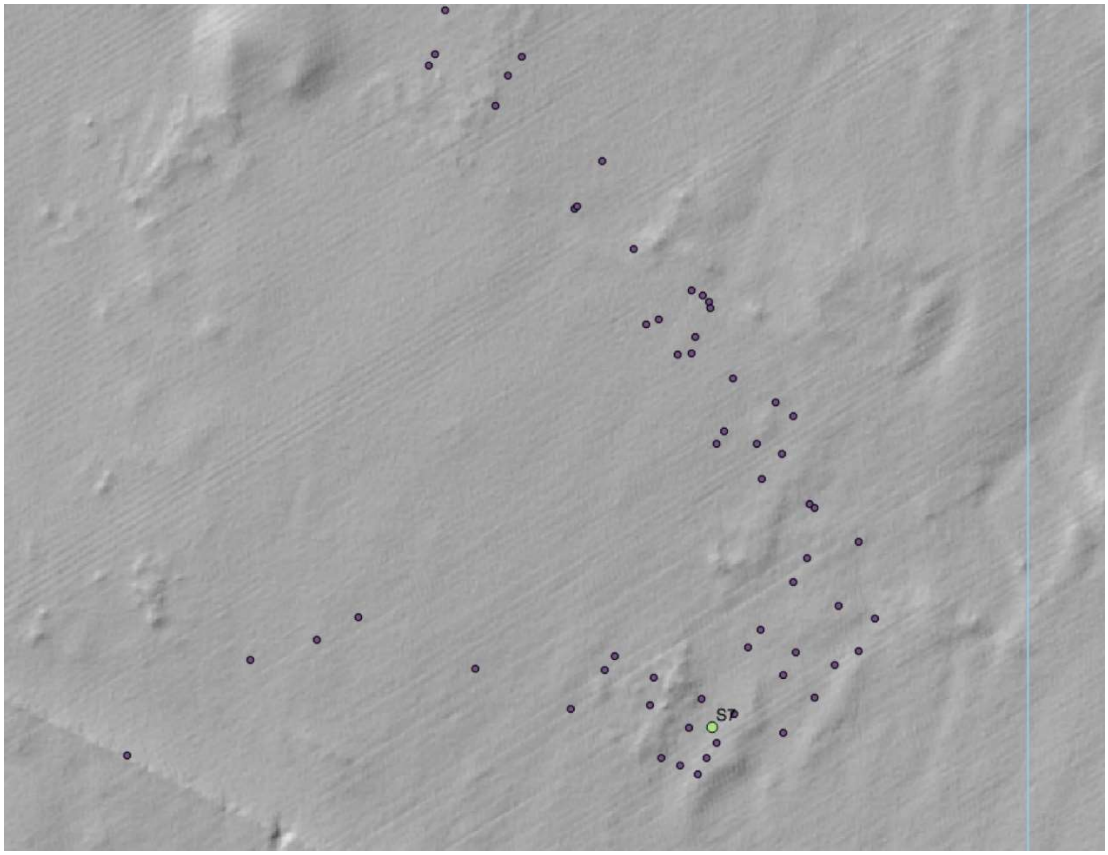
As viewed from these points on the plaza, the Temple entrance, appearing just above and behind the towers, or in gaps between them, broadly coincided with the position of sunset at the June solstice. Figure 2-43 gives an indication of the area of the plaza from which the June solstice sun will be seen to set directly behind the Temple entrance: it is that area for which the declination is between +23.5° and +24.0°. Broadly speaking, this is the part of the plaza where the entrance appears in, or above, the gap between Towers 9 and 8. The cultural implications of the resulting "hierophany for the masses" are discussed in Section 2.a.1.b The Fortified Temple.

Finally, as noted by (Ghezzi 2007), there is an intriguing correlation between the area of the plaza from which the Temple platform is visible and the area from which the geoglyphs to the SSW of the Fortified Temple are visible (Figure 2-44). The geoglyphs only seem to be visible from parts of the plaza from which the entrance to the Temple entrance is also visible. Furthermore, there is an additional "cut-off" more or less exactly beyond the part from which the June solstice sun aligns with the Temple entrance. Whether this is significant or could cast any light upon the purpose and possible meaning of the geoglyphs, is impossible to say at this time.

(a)



(b)



(c)

Figure 2-42. (a): Points in the plaza from which the entrance to the Temple of the Pillars just disappeared from view. The green dots indicate points defining the edge of the visibility envelope as determined directly in the field; the computer-generated viewshed is superimposed. (b): Close-up of the area around which the entrance to the Temple of the Pillars just disappeared from view behind the southernmost towers (without the superimposed computer-generated viewshed). (c): Photograph of the horizon to the WNW as viewed from a point close to the limit of visibility on the solstitial line (marked as S7 in [b]). The entrance to the Temple of the Pillars appears between Towers 13 and 12 on the closer ridge.

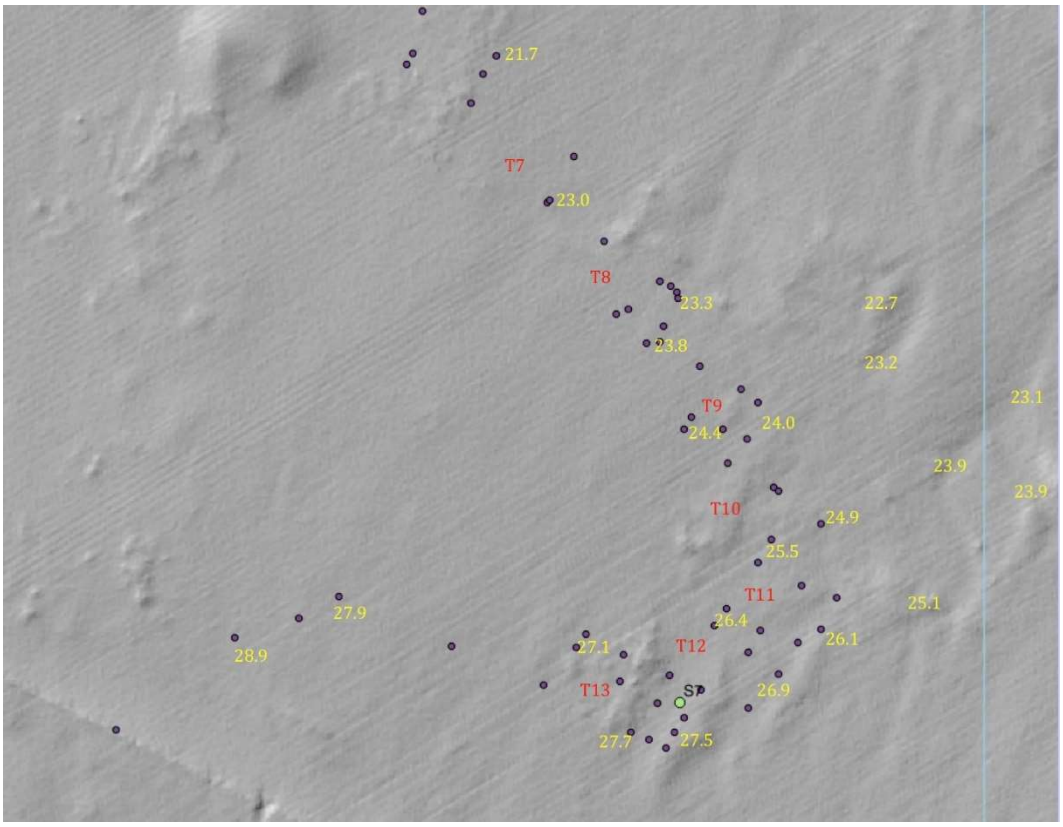


Figure 2-43. The plaza area as shown in Fig 2.b–6 (b), with surveyed points marking the edge of the visibility envelope for the Temple entrance, overlain with numbers (in yellow) showing the declination of the horizon above the Temple entrance as viewed from that spot. "Tower shadows" created when the tower in question obscures the view of the Temple entrance, are labeled in red.

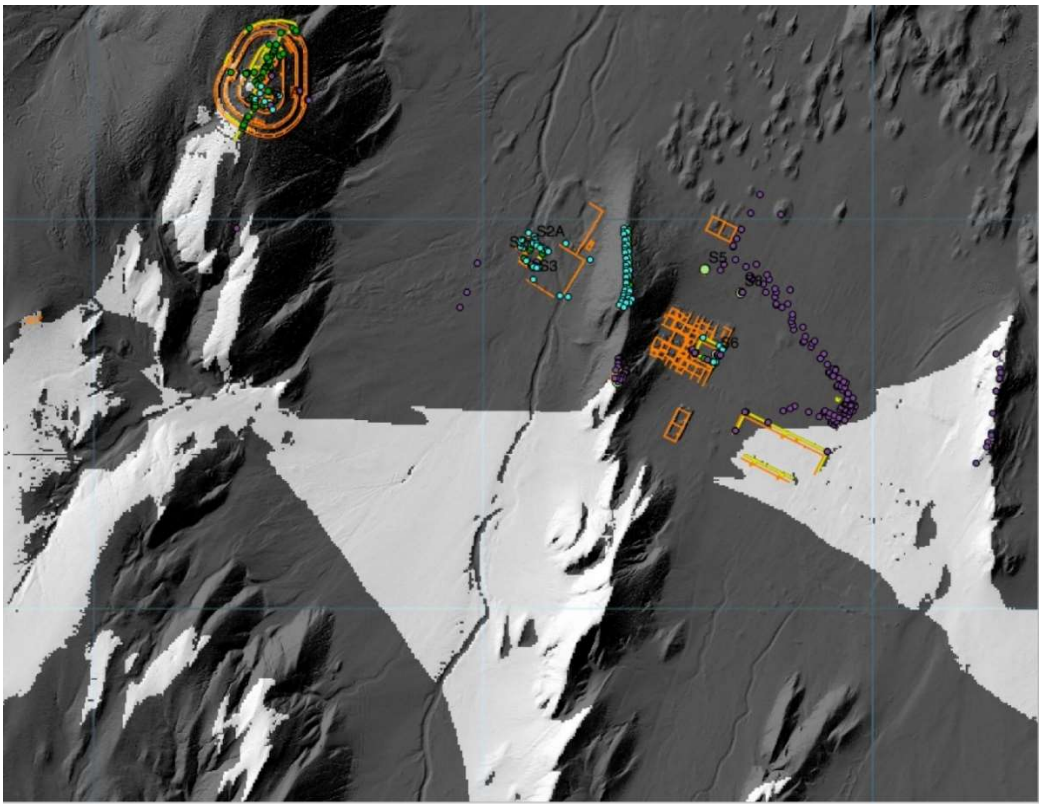


Figure 2-44. Part of the viewshed from the geoglyphs, which also shows the area of the plaza from which the geoglyphs can be seen

2.b.6 The "site axis" and the broadly solstitial site alignment of all the principal buildings at the site

Other than the line of towers and the perimeter of the Fortified Temple, the orientations of buildings and other structures over a wide area generally conform to an overall grid plan consistent to within about 6°. The orientations of the principal rectangular buildings and walls at Chankillo are as follows (summarized in Table 2-6):

- *Temple of the Pillars*. The outer walls have a WNW–ESE orientation of 119.0°/299.0° and a SSW–NNE orientation of 25.4°/205.4°. They therefore deviate from perpendicularity by 3.6°.
- *Observatory Building* (OB). The outer walls have a WNW–ESE orientation of 121.7°/301.7° and a SSW–NNE orientation of 30.9°/210.9°. The walls therefore deviate from perpendicularity by 0.8°. The corridor on the SSW side widens towards the WOP at its eastern end and has a mean orientation of 121.1°/301.1°.
- *Structure 5 adjacent to the Observatory Building* ("OB2"). The east, west and north walls form three sides of a rectangle with an orientation of 30.8°/120.8°/210.8°/300.8°. However, the south wall deviates slightly from this, with an orientation of 121.5°/301.5°.
- *Outer enclosure walls*. The SSW-NNE enclosure wall to the ESE of OB and OB2, and the surviving parts of the adjacent enclosure walls, are oriented with azimuths of 30.5°/210.5°, 121.9°/301.9°, and 121.5°/301.5° respectively.
- *Administrative Center*. Measurements of the sides of the atrium yield a WNW–ESE orientation of 115.6°/295.6° and a SSW–NNE orientation of 26.6°/206.6° respectively.
- *Large rectangular building centered at (804760,8941400)*. The long wall on the NNE side of this enclosure yields the most reliable orientation, 115.7°/295.7°, while the shorter wall opposite yields 115.1°/295.1°. The west and east walls yield 26.5°/206.5° and 25.3°/205.3° respectively.

Table 2-6. The orientation of the principal rectangular buildings and walls at Chankillo. The azimuths quoted are true azimuths and given in one direction only (towards the ESE or NNE)

Structure	Azimuth WNW to ESE	Azimuth SSW to NNE	Deviation from perpendicularity (Az1–Az2) –90°
Temple of the Pillars	119.0	25.4	+3.6
Observatory Building (OB)	121.7	30.9	+0.8
Adjacent building (OB2)	121.1	30.8	+0.3
Outer enclosure walls	121.7	30.5	+1.2
Administrative Center	115.6	26.6	–1.0
Large rectangular building centered at (804760, 8941400)	115.4	25.9	–0.5

A 650m-long wall connected to several buildings in a further plaza to the east, running from approximately 1.3 km to 2.0 km to the ESE of the towers, has approximately the same orientation (114.3°/294.3°) and means that the overall grid plan extends for well over 2 km.

A straight line drawn to connect the entrance to the Temple of the Pillars and the single direct entrance to Administrative Center would pass through the center of the Observatory Building and also the gap between Towers 12 and 13, where the southern end of the line of towers bends round until it is perpendicular to this axis (Figure 2-1). This "site axis", with an azimuth of 118.8°/298.8°, appears to be the basis for the wider grid. Both the WNW–ESE and SSW–NNE orientations are consistent to within about 1° among each local group of structures, as would be expected if the construction followed a broad overall plan but used local foresights to achieve consistency within each specific locality. The fact that the opposite walls of large rectangular structures are generally only parallel to within about 1°, and that their walls are only perpendicular to within about the same amount, suggests that the required level of precision was no greater than this. The Temple of the Pillars, whose walls are 3.6° off the perpendicular, is an exception, implying that this occurred for a specific reason, but it is not obvious what this reason was (astronomical or otherwise).

The varying altitude of the horizon in either direction from different points around the site, due to the undulating landscape crossing valleys and ridges, makes it unlikely that a consistent type of astronomical observation could have been carried out repeatedly in order to set out the grid orientation in different areas. However, it is possible that an astronomical observation from a particular starting place originally defined the direction of the site axis, which was then propagated across the site by other means. The obvious candidate is December solstice sunrise /

June solstice sunset, and Table 2-7 shows the azimuth of these solstitial events for different horizon altitudes. A comparison of Table 2-6 and Table 2-7 shows that only the orientation of the Administrative complex and other buildings in the eastern plazas could have been directly defined in relation to the solstices, and in fact only in relation to the June solstice sunset. The remaining structures throughout the site broadly follow the solstitial alignment in consequence.

Table 2-7. The azimuth of December solstice sunrise and June solstice sunset at the latitude of Chankillo (–9.55°), for different horizon altitudes. All angles in degrees and to the nearest 0.05°

	December solstice sunrise			June solstice sunset		
Horizon altitude	Lower limb (δ = –23.5°)	Centre (δ = –23.75°)	Upper limb (δ = –24.0°)	Upper limb (δ = +23.5°)	Centre (δ=+23.75°)	Lower limb (δ = +24.0°)
0	113.95	114.2	114.45	293.75	294.0	294.25
5	113.05	113.3	113.55	294.85	295.1	295.35
10	112.4	112.65	112.9	296.1	296.35	296.6
15	111.95	112.2	112.45	297.6	297.9	298.15

2.c History and development

Previous Research

There is a long history of exploration and research at Chankillo (Raimondi 1873, Chalon 1884, Raimondi 1909, Shippee 1932, Roosevelt 1935, Kroeber 1944, Willey 1951, Reiche and Fung 1956, Tello 1956, Olson and Broecker 1959, Leicht 1960, Thompson 1961, Collier 1962, Kosok 1965, Lanning 1967, Fung 1969, Fung and Pimentel 1973, Squier 1973 [1877], Middendorf 1973 [1892], Delibrias, Guillier et al. 1974, Thompson 1974, Topic and Topic 1978, Carlevato 1979, Lopez Raygada 1982 [1944], Pozorski and Pozorski 1987, Topic and Topic 1987, Wilson 1988, Topic 1989, Wilson 1995, Topic and Topic 1997, Wilson 1999, Raimondi 2012 [1874]).

Throughout the record, there are common themes worth discussing. For instance, several names have been offered for the site. The first to appear in print, Chancayillo and Chancaillo, were reduced to Chankillo (or its Hispanicized version, Chanquillo), and as such it has survived in the literature. The name Chankillo was used in Tello's posthumous book (Tello 1956), based on his field notes from the 1930s, but C. Roosevelt (1935), who traveled with Tello, was the first to use it in print. Collier (1962), Thompson (1961) and others have used the Hispanicized spelling. Fung and Pimentel (1973), and most scholars after them use Chankillo. This is the spelling employed by archaeologists who studied the Casma valley in great depth (Tello, Fung, Pozorski), the first archaeologist to carry out systematic research at the site (Fung), and cultural authorities of Peru (INC 2008), thus leaving little doubt about which should be preferred.

The full extent and components of the Chankillo site were only recognized in the 1980s. Many explorers and some pre-1980 scholars used the name to refer only to its hilltop fortification. They failed to include vital sectors, especially large buildings and *plazas* east of the Thirteen Towers, in their interpretations. Some considered the Thirteen Towers and their surroundings part of the site, while others discussed them as a separate site. Pozorski and Pozorski (1987) were the first to consider as a single site all the components recognized today. The Chankillo Project, through its survey and mapping program, has informed decisions by the Peruvian cultural authorities to recognize Chankillo as a national cultural heritage of the "monumental archaeological zone" category (INC 2008).

There is uncertainty in the previous literature on the chronological placement of Chankillo. Most commonly, it has been assigned by archaeologists to the Early Horizon or the Early Intermediate period (Table 2-1). Two previous ^{14}C dates (Olson and Broecker 1959, Delibrias, Guillier et al. 1974) have been accepted uncritically to give the site an Early Horizon date. The associated Patazca pottery style was assigned a post-Early Horizon relative dating from previous research (Collier 1962, Carlevato 1979). Wilson's 1995 report defined a preliminary chronological sequence for the Casma valley and assigned Chankillo to the Patazca period (350 BC – 0 AD), which he cross-dated with the end of the Early Horizon and beginning of the Early Intermediate Period in Central Andean chronology.

The previous literature shows great disagreement about the function of the Fortified Temple at Chankillo, with interpretations that range from a fort to a setting for ritual warfare. Most researchers, impressed by its hilltop location, high walls, and baffled entrances, considered Chankillo a fort or refuge. Though some considered the Thirteen Towers "defensive outposts," many acknowledged that sector of the site might have had public and/or ceremonial functions; a few favored a calendrical-astronomical interpretation based on the number of towers, either solar or lunar in association. Overall, most researchers, while recognizing the probable ceremonial aspects of the site, gave primacy to the defensive function.

Surprisingly, there was a disagreement on the number of towers –thirteen or twelve. Kroeber (1944) did not hesitate to point out Middendorf´s (1973 [1892]) apparent error in print. However, as Ghezzi and Ruggles (2008) showed, from a number of viewing positions in the open public spaces of Chankillo to the east, including the Eastern Observing Point, only twelve towers are visible: the southernmost tower is intentionally hidden from view behind the larger tower 12. It

is likely that Middendorf only observed the long line of towers from the eastern *plaza* of Chankillo.

Middendorf, Reiche, and Fung coincided that the gates of the Fortified Temple are defensive, not only because of their baffled design, but also because they could be easily blocked off in case of danger. This is important because the defensive purpose of the baffled gates has been a major point of contention, with some authors calling attention to their apparently excessive number and the outside location of their doors.

Worth discussing is an observation found in our literature review that the rectangular structure inside the Fortified Temple known as the Temple of the Pillars was "so destroyed" that its layout could not be recognized. Even the excellent map of Reiche and Fung (1956) is only a sketch when it comes to this temple. It was not until Pozorski and Pozorski (1987) worked at the site that a reasonable plan of this structure appeared in print. Unlike the rest of the site, where standing architecture is relatively easy to read, the Temple of the Pillars has an unusual overburden of rubble that suggests building burial and obscures its ground plan. Much of the most current interpretation of the hilltop building rests on the idea that this temple was artificially buried, and may have been a locus of ritual termination, or a target of attack and violent destruction.

Kosok was the first to suggest that ceremony was a primary function of Chankillo. Topic and Topic later argued persuasively against its defensive function, noting the absence of parapets or slingstones, and the location of doors outside of baffled gates defied military logic. They believed Chankillo is best viewed as a ceremonial setting for ritual battles. Though these different positions on the function of Chankillo are influenced by theoretical perspectives on Andean warfare, a methodological issue has also distorted the arguments: scholars who only considered "Chankillo" to be the Fortified Temple, or who focused on it exclusively, have overwhelmingly favored the interpretation of the site as a fortification or refuge. On the contrary, researchers with a more comprehensive view of the site, especially those with a clear interest in the Thirteen Towers and associated public spaces, have leaned towards its interpretation as a ceremonial center, with an important defensive component.

Current research

As a result of multidisciplinary archaeological research and conservation carried out at Chankillo since 2001 (Ghezzi 2002, Ghezzi 2003, Ghezzi 2004, Morales 2011, Guadalupe 2012, Magadán 2012, Coahila and Ghezzi 2013, Ghezzi, Alvarez et al. 2013, Salazar 2013, Salazar 2013, Ghezzi, Gamboa et al. 2014, Ghezzi, Gonzales et al. 2014, Gonzales, Gargate et al. 2014, Morán 2014,

García 2017, Ghezzi, Suarez et al. 2017, Padilla 2017, Paz 2017, Ruggles 2017, Vásquez 2017, De las Casas 2018, Ghezzi, Alvarez et al. 2018, Huayhua and Sueldo 2018, Morales 2018, Ghezzi, Alvarez et al. 2019, Ghezzi, Alvarez et al. 2019) we understand a good deal about its chronology, its constructive history, the functions of its many buildings and their architectural details, the relationship between astronomy and the set of associated cultural processes, and the violence with which the Fortified Temple was attacked.

From a historical perspective, two themes stand out: the visual integration of elements of the landscape, both natural and constructed in relation to the skyscape, as indicators of the cyclical movement of the sun and therefore the passage of time; and the relationship between war, power, and ideology, on which Chankillo gives us empirical information that is thus far unparalleled in the archaeology of the Andes.

The span of the construction, occupation, destruction, and abandonment of Chankillo is very short, apparently lasting less than half a century. A large sequence of cultural materials dated by relative (pottery styles) and absolute (dendrochronology and ^{14}C) methods demonstrates this. Based on these studies (Ghezzi 2016), it has been possible to establish the following chronological indicators of the architectural and occupational history of the site (Figure 2-45):

- There is compelling evidence that natural features in the eastern horizon visible from the sacred entrance to the Temple of the Pillars were used as natural markers, especially to date the equinox. This alignment may have determined the location of the Temple of the Pillars, itself a known origin point for the broadly solstitial orientation of the entire site, and probably a precursor to the concept of building a Solar Observatory at this location. This likely use of the eastern horizon is undated but would predate the construction of all the monuments at Chankillo.
- The oldest dates associated with the beginning of the occupation range between 244 and 202 BC, which correspond to the beginning of construction at the Temple of the Pillars.
- High-precision dates obtained from the wooden lintels used in the ceiling of the gates of the Fortified Temple give a cutting date of 214±7 BC. This is considered to represent the last construction stage of this building.
- It is not possible to define the temporal relationship between the Temple of the Pillars and the walls that surround it. Archaeological and dendrochronological data indicate that the the Fortified Temple was a large-scale construction project executed very quickly, and thus the different sectors could have advanced in parallel or with small gaps in time.

- The construction of Building 4 in the area of the Administrative Center has been dated to 213±11 BC, contemporary with the construction of the Fortified Temple.
- The occupation of the Temple of the Pillars is dated between 224 and 195 BC.
- The occupation of the Observatory Building has been dated between 234 and 195 BC. It is contemporary with the occupation of the Temple of the Pillars.
- The destruction of the Temple of the Pillars has a high-precision date of 202±9 BC.
- The identification of buildings with a halted construction, and the presence of quarries of building materials, especially stone, as well as the identification of accumulations of construction materials in the routes between the quarries and the main buildings, indicate that at the time of the attack and the destruction of the Temple of the Pillars, and the consequent abandonment, Chankillo was in the process of constructing and expanding its facilities to the east. This destruction and abandonment occurred suddenly and violently, as the buildings were unfinished, and the tools used to work the stone were abandoned.
- The Fortified Temple was abandoned for over a millennium before it was reoccupied, yet without its defensive, ritual or astronomical functions. Late Intermediate Period occupants (1100-1470 AD) left human burials, graffiti on the surviving walls, offerings, and some possible constructions of ephemeral use. This occupation is dated between 1051 and 1286 AD. It is likely that there is much more evidence of the occupation of the area at this time in sectors not investigated within the Chankillo Monumental Archaeological Zone.
- There is a brief Inca occupation, identified through a typical ritual offering to fertility, placed on the first step of the northern staircase of the northernmost tower (Tower 1) of the Thirteen Towers. It is dated between 1293 and 1511 AD. At the Solar Observatory of Chankillo, this position is associated with the June (winter) solstice, and among the Incas this is the date of Inti Raymi, their most important festival.
- So far, no evidence of subsequent historical occupations has been recovered within the Chankillo Monumental Archaeological Zone. After the 1970 earthquake that devastated the Ancash region, small human populations settled on the edges of the site.

Despite the short duration of the process of construction, use, destruction and abandonment of Chankillo, the meticulous planning of this ceremonial and astronomical center was a product of knowledge accumulated since the arrival of the first inhabitants, ten millennia ago, through later social processes initiated around 3500 BC with the construction of large ceremonial centers in Casma. This long cultural history manifests in the masterful way in which the builders of

Chankillo integrated human constructions and the environment, using both the built architecture and natural viewsheds for the production and cultural application of astronomical knowledge.

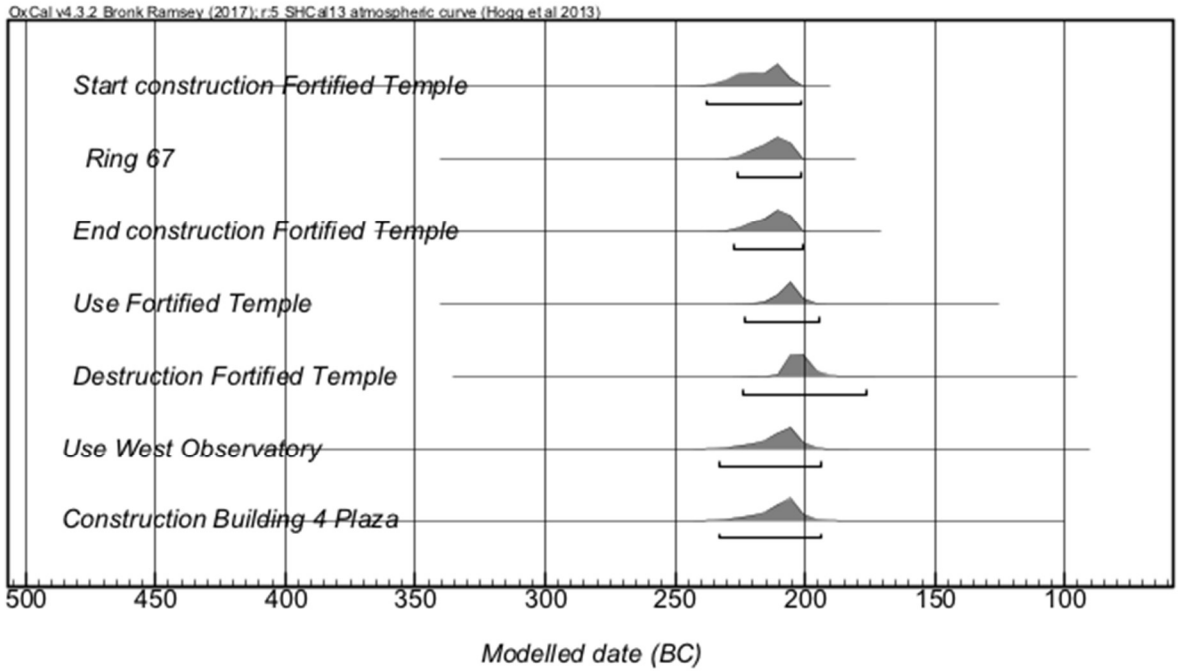


Figure 2-45. Bayesian modeling of radiocarbon dates from Chankillo